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The Engineer

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PUBLIC NOTICES

Hong Kong Waterworks.
SHING MUN SCHEME.
PRELIMINARY NOTICE.

The Crown Agents for the Colonies will shortly be prepared to consider TENDERS from approved firms for the CONSTRUCTION of the PIPE CONNECTING MAINS across HONG KONG HARBOUR, between VICTORIA and KOWLOON.

Preliminary particulars as to the general requirements of the proposed works may be obtained at the office of the CONSULTING ENGINEER, Mr. William Fairley, M. Inst. C.E., Parliament Mansions, Victoria-street, Westminster, S.W. 1, as it will be necessary for firms wishing to tender to obtain certain local information. Appointments must be previously arranged. 8173

The Director-General,
India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E., invites TENDERS for—

1. BEARING PLATES for RAILS.
2. INTERLOCKING STEEL SHEET PILING.
3. 25-Ton HAND POWER BREAKDOWN CRANE.

Tenders due on the 26th May, 1925, for No. 1, on the 27th May, 1925, for No. 2, and on the 28th May, 1925, for No. 3.

Tender forms obtainable from above. 9210

War Department.
CHATHAM DISTRICT.
OLD MACHINERY FOR SALE AND REMOVAL.

The Secretary of State for the War Department is prepared to receive TENDERS for the PURCHASE and REMOVAL of—

5 A.C. CEILING FANS; 2 A.C. MOTORS; 2 VENTILATING FANS; 1 SLOTTING MACHINE; 2 OIL ENGINES; 1 D.C. DYNAMO; 2 PILLAR DRILLING MACHINES; 1 SHAPING MACHINE; 6 LATHES; 2 CRANES; 1 TRAVELLER; 2 D.C. MOTORS; 2 LENGTHS LINE SHAFTING; 2 CIRCULAR RACERS; and 1 PLANING MACHINE.

Forms of Tender, with conditions of sale and any further information, can be obtained from the Commanding Royal Engineer, Inner Lines, Chatham.

Tenders will be received until Twelve o'clock Noon on Monday, 8th June, 1925.

The Secretary of State for the War Department does not bind himself to accept the highest or any Tender. 9169

Civil Engineers (2) Required by the GOVERNMENT of the GOLD COAST for the PUBLIC WORKS DEPARTMENT, for two tours of from 12 to 18 months' service each. Free passages and quarters and liberal leave on full salary. Outfit allowance of £60 on first appointment. Salary, £480 for the first three years of service and then £510, rising to £720 by annual increments of £30, and thence rising to £920 by annual increments of £40. Candidates, aged 25-35, preferably Associate Members of the Institution of Civil Engineers, should be good Surveyors and have had considerable experience in practical Town Planning and be conversant with Ministry of Health procedure on Town Planning.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/13,510. 8174

Draughtsman Required by the GOLD COAST GOVERNMENT for RAILWAY DEVIATIONS, for a tour of 12 to 18 months' service. Salary, £500 a year, with free quarters or a field allowance of £90 a year in lieu. Free passages and liberal leave on full salary. Candidates, age 25 to 35, must be experienced Draughtsmen, able to Prepare Detail Drawings of Structures, &c., and be capable of Using Level and Theodolite in the field.—Apply at once by letter, giving brief details of training and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/13,508. 9209

Quantity Surveyor Required for the PUBLIC WORKS DEPARTMENT of the GOLD COAST, for two tours of eighteen months' service. Salary, £480 a year for the first three years of service, then £510, rising to £720 a year by annual increments of £30, and thence rising to £800 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Free passages and quarters, and liberal leave on full salary. Candidates should be between the age of 25 and 35. Must have been thoroughly trained in either an Architect's or Builder's Office in Building Construction in all its details, and have then been engaged in a first-class Quantity Surveyor's Office, and be thoroughly conversant with Taking-off, Abstracting, Billing, Estimating and Measuring-up.—Apply at once by letter, giving age and brief details of training and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/13,486. 8175

Technical Assistant Required for the Marine Aircraft Experimental Establishment, Felixstowe. Candidates must have sound training in engineering, with an Honours Degree in that subject or its equivalent, and experience of aircraft design, preferably that of flying boats and seaplanes. Must be willing and physically fit to fly.

Commencing salary £250 a year plus Civil Service bonus (making a total of £377) on the scale £250, advancing by annual increments to £450 a year plus bonus, with benefits of Federated Universities Superannuation Scheme. Preference will be given, other things being equal, to an ex-Service man.

Apply in writing, giving full particulars of experience and qualifications, to SECRETARY, Air Ministry, Adastral House, Kingsway, W.C. 2. 9191

Bombay, Baroda, and Central India Railway Company.

The Directors are prepared to receive up to Noon on Wednesday, 3rd June, TENDERS for the SUPPLY of—

1. BALLAST WAGONS,

and up to Noon on Wednesday, 27th May, TENDERS for the SUPPLY of—

2. WHEELS and AXLES for CARRIAGES (Sorbitic Tyres).
3. WHEELS and AXLES for WAGONS.
4. PHOSPHOR TIN.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each for Nos. 1, 2 and 3, and 10s. each for No. 4 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: 91, Petty France, Westminster, S.W. 1.
11th May, 1925. 9168

PUBLIC NOTICES

City of Cardiff Education Committee.
THE TECHNICAL COLLEGE.

Principal: CHARLES COLES, B.Sc. (Lond.).

The SERVICES will be REQUIRED in September next of TWO FULL-TIME ASSISTANT LECTURERS in ENGINEERING, qualified in each case to teach up to Honours B.Sc. standard. The main subjects required will be those of Mechanical and Civil Engineering, but a good knowledge of Electrical Engineering will be a recommendation.

Salary scale: £300-£15-£450 per annum, with such variation in the scale as may be necessary by the application to Cardiff of the Burnham Award.

Applications on foolscap paper, stating age, full qualifications, teaching and other experience, and giving copies of not more than three recent testimonials, should reach the Principal (from whom further particulars may be obtained) on or before Saturday, 30th May.

The successful candidates will be required to pass a medical examination by the Authority's Medical Examiner for Teachers at Cardiff before commencing duties, and to contribute under the local pensions scheme, if not accepted under the School Teachers (Superannuation) Acts.

JOHN J. JACKSON,
Director of Education.
City Hall, Cardiff. 9165

Norton and Gregory Engineering Scholarships, 1925.

The following Scholarships, total value £450, have now been awarded:—

Arthur Aylwin Fletcher-Jones, Monkton Combe School, near Bath: £100 per annum, tenable for 3 years at Cambridge University.

Richard Peter Alston, Clifton College: £50 per annum, tenable for 3 years at Cambridge University. 9192

Bengal-Nagpur Railway Company, Limited.

The Directors are prepared to receive TENDERS for 5 10-Ton HAND TRAVELLING CRANES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, E.C. 2, on or after 14th May, 1925.

A fee of 20s. will be charged for the specification, which is NOT returnable.

Tenders must be submitted not later than NOON on Tuesday, 26th May, 1925.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS,
Secretary.
9203

The South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of:—

PAINTS, &c., AND VARNISHES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Paints, &c.," must be left with the undersigned not later than Twelve Noon on Friday, the 29th May, 1925.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of the specification.

A. MUIRHEAD,
Managing Director.

91, Petty France, Westminster, S.W. 1.
12th May, 1925. 9190

PUBLIC NOTICES

City of Liverpool.

The Corporation are prepared to receive TENDERS for the SUPPLY and DELIVERY of various classes of TRAMWAY MATERIAL, as under—

Schedule No. 1.—STEEL TRAMWAY RAILS.
Schedule No. 2.—STEEL TRAMWAY RAIL FISH-PLATES.
Schedule No. 3.—STEEL FISH BOLTS.
Schedule No. 4.—STEEL TIE-BARS.
Schedule No. 5.—COPPER BONDS.

Firms are required to state clearly, when making application for the necessary Tender forms, the name and number of the schedule for which they desire to be furnished with Tender forms.

Duplicate forms of Tender for record purposes will NOT be supplied.

Tender forms will be forwarded UPON RECEIPT OF APPLICATION IN WRITING to—

The City Engineer,
Municipal Buildings, Dale-street,
Liverpool.

Tenders must be sealed and enclosed in the official envelopes provided, endorsed in accordance with the instructions given on the form of Tender, and FORWARDED THROUGH THE POST, addressed to

The Town Clerk,
Municipal Buildings,
Liverpool.

LATEST TIME AND DATE FOR RECEIPT OF TENDERS—TEN O'CLOCK A.M. ON FRIDAY, THE 22nd MAY, 1925.

WALTER MOON, Town Clerk.
29th April, 1925. 9133

County Borough of Blackburn.
ELECTRICITY DEPARTMENT.

The Electricity Committee have for immediate DISPOSAL and REMOVAL the following PLANT now lying at their JUBILEE-STREET DISTRIBUTION STATION, which can be inspected at any time:—

LOT 1.—Two Westinghouse 2000 K.W. Turbo-Alternators, 6600 volts, 50 cycles, 3000 r.p.m., complete with Exciters, Condensers, Electrically Driven Extraction and Air Pumps.

LOT 2.—One Westinghouse 400 K.W. D.C. Motor Generator, complete with Starting and Control Panel, 440-550 volts and vice versa.

LOT 3.—Seven Lancashire Boilers, 33ft. by 8ft. 6in., 185 lb. pressure, fitted with Proctor's Stokers and McPhail's Superheaters.

LOT 4.—One Rees-Roturbo Circulating Pump, capacity 200,000 gallons per hour, head 72ft., complete with 93 H.P., 440 v. D.C. Motor and Starting Gear, Spare Armature, and Field Coil.

LOT 5.—One Rees-Roturbo Circulating Pump, capacity 100,000 gallons per hour, head 50ft., complete with 38 H.P. 440 v. D.C. Motor and Starting Gear, Spare Armature, and Field Coil.

LOT 6.—Two Hall's Compound Long-stroke Feed Pumps, 5000 gallons per hour.

LOT 7.—One Weir Centrifugal Steam Turbine-driven Feed Pump, 10,000 gallons per hour against 185 lb. per square inch.

LOT 8.—One Westinghouse Rees Roturbo Steam Turbine-driven Pump, 7500 gallons per hour against 185 lb. per square inch.

LOT 9.—One Hart's Wet Air Filter, complete with Motor, suitable for 2000 K.W. Alternator.

LOT 10.—One Wright Water Purifying Plant, with Quartz Sand Filters, capacity 8000 gallons per hour.

LOT 11.—One Bruce Peebles 300 H.P. Shunt-wound Motor, 440 v., 240-312 revs. per minute, with Liquid Starter and Control Panel.

LOT 12.—One Bradford Cooling Tower, capacity 200,000 gallons per hour (Davenport Engineering Company).

LOT 13.—Two E.C.C. 95 H.P. D.C. Motors, 440 v., 430 revs., with Starters.

The Corporation are open to consider OFFERS for the above PLANT.

The highest or any Tender will not necessarily be accepted.

Tender forms and particulars can be obtained from P. P. WHEELWRIGHT, M.I.E.E., Engineer and Manager, Corporation Electricity Works, Jubilee-street, Blackburn.
12th May, 1925. 9193

PUBLIC NOTICES

CONTRACTS, &c.

Great Southern Railways (Ireland).
CONTRACTS, 1925.

The Directors of the Great Southern Railways Company are prepared to receive TENDERS for the SUPPLY of the undermentioned STORES for six months commencing 1st July, 1925, and alternatively for twelve months commencing the same date.

	No. of Form.
Acid, Sulphuric	30
Asbestos Sheeting, &c.	40
Baskets	10
Bolts, Nuts, and Rivets	15
Brooms and Brushes	13
Brass Fittings for Carriages	18
Do. do. for Water	28A
Do. do. for Gas	28B
Canvas and Sacks	6
Castings, Mall, Iron	11
Carriage Laces	7A
Cloth for Carriages	7C
Clothing, I.E., proofed	9B
Coach Screws and Washers	15
Colours	2
Corks	39
Cotton Waste	5A
Crucibles	41
Drysalteries	3
Emery and Glass Cloth, &c.	28
Files and Tool Steel	20
Fire Bricks and Clay	33
Foundry Requisites	42
Galvanised Sheets, Buckets, &c.	23
Grates, Stoves	24
Grindstones	28
Glass, Sheet, and Plate	27A
Glass and China Sundries	27B
Hardware Brass and Iron	17
India Rubber Goods	9A
Implements, Sundry	21
Iron Tubes and Fittings	29
Leather and Leather Goods	12
Locks and Keys	19
Mantles for Gas	26G
Mats, Fibre	10
Nails	31
Nuts, Hex., Black and Bright	15A
Packings	40
Plumbago	41
Rain Water Pipes and Gutters	25
Ropes, Twine, and Flax	4
Soaps	36
Sewer Pipes, Plaster of Paris, &c.	32
Shovels, Spades, &c.	21A
Sponge Cloths	5
Signal Wire Pulleys	11
Screws and Split Pins	14
Steel Tubes	20
Tin Plates	22
Waste	5A
Waterproof Clothing	9B
Wicks	5
Wire, Fence, and Signal	30A
Wirework	30B

Forms of Tender can be obtained on payment of 6d. each from the Stores Superintendent, General Stores Department, G.S. Rys., Inchicore, Dublin. Applications for forms by post must be accompanied by postal order. STAMPS CANNOT BE ACCEPTED. All inquiries for information should be also directed to the Stores Superintendent.

Patterns may be inspected at the General Stores Department, Inchicore, on and after the 18th inst., between the hours of 10 a.m. and 4 p.m. (except on Saturdays).

Tenders must be enclosed in the special envelope supplied for the purpose with each Schedule, and must be posted so as to be with the undersigned before 10 a.m. on Thursday, 4th June, 1925.

The Directors will not consider any Tender unless it is furnished on the Company's form, and do not bind themselves to accept the lowest or any Tender.

By Order,
C. E. RILEY, Secretary.
Kingsbridge Terminus, Dublin, May, 1925. 9196

PUBLIC HEALTH ACT, 1875.

Rural District of St Albans.
HERTFORDSHIRE.
CONTRACT No. 2.

The Rural District Council of St. Albans, acting as the Sanitary Authority for the said District, are prepared to receive TENDERS for the SUPPLY of OIL ENGINES, AIR COMPRESSORS, RECEIVERS and SEWAGE EJECTORS.

Particulars and specification may be obtained at the offices of the Consulting Engineers, Messrs. Howard Humphreys and Sons, 28, Victoria-street, Westminster, on and from Monday, the 18th of May, until Monday, the 25th of May, between the hours of 10 a.m. and 4 p.m., upon payment of a deposit of One Guinea, which deposit will be returned upon receipt of a bona fide Tender, which is not subsequently withdrawn by the contractor.

The successful tenderer will be required to execute a contract deed, the draft of which may be seen at the offices of the Consulting Engineers when the drawings are inspected.

Tenders must be on the official form, each Tender in a sealed envelope, marked "Tender for London Colney Main Drainage, Contract No. 2." Tenders must be accompanied by the general conditions and specification as issued by the Consulting Engineers.

Each Tender must be signed in the handwriting of the tenderer or his authorised agent.

The Council does not bind itself to accept the lowest or any Tender.

Tenders must reach the undersigned by 9 a.m. on Tuesday, the 2nd of June, 1925.

Given under my hand the 8th day of May, 1925.
E. F. W. HIKATT,
Clerk to the St. Albans R.D.C.

Union Offices,
St. Albans. 9151

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PUBLIC NOTICES

Port of Bristol.

20,000-TON SILO GRANARY, ROYAL EDWARD DOCK, AVONMOUTH.

The Docks Committee are prepared to receive TENDERS for the CONSTRUCTION of a FERRO-CONCRETE-BUILT SILO GRANARY of 20,000 tons capacity, carried on Ferro-concrete Piles.

On and after Friday, the 15th day of May, 1925, copies of the specification and contract drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid to the General Manager and Secretary of the Docks Committee, 19, Queen-square, Bristol. ALL CHEQUES MUST BE MADE PAYABLE TO THE BRISTOL DOCKS COMMITTEE. The deposit of £5 will be returned to all bona fide tenderers after the receipt of a Tender with all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for Granary," addressed to the General Manager and Secretary of the Docks Committee, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings before 10 a.m. on Monday, the 15th day of June, 1925.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Chief Engineer,
Port of Bristol.

Chief Engineer's Office,
Avonmouth Docks,
8th May, 1925. 9111

County of Surrey.

HIGHWAYS AND BRIDGES DEPARTMENT.

APPLICATIONS are INVITED for the APPOINTMENTS of :—

(1) An ASSISTANT RESIDENT ENGINEER at a salary of £8 per week.

(2) A JUNIOR SURVEYING ASSISTANT at a salary of £3 per week.

The appointments will be temporary and the probable duration not less than 6 months, subject to satisfactory service.

Applications, in writing, on the prescribed forms, which may be obtained from the undersigned, must reach the undersigned not later than Monday, 25th May, 1925, in envelopes endorsed "Appointment of Assistant Resident Engineer" or "Junior Surveying Assistant," as the case may be.

W. P. ROBINSON, A.M. Inst. C.E.,
County Surveyor.

County Hall, Kingston-on-Thames,
12th May, 1925. 9182

SITUATIONS OPEN

WANTED, an ENGINEER, Whose Duties will Consist of the Laying of Cables and the Construction of Overhead Lines and Sub-stations on a Supply System.

Address applications, stating age, experience, and salary required, 9157, The Engineer Office. 9157 A

WANTED by a Large Waterworks Company (in England), a SUPERINTENDING INSPECTOR —permanent employment—about 35 years of age. Must be of active habits, good address and health, thoroughly acquainted with Modern Plumbing Work, Water Fittings and Installations in large business and trade establishments, as well as in private houses, and capable of advising consumers thereon. A thorough knowledge of Waste Detection in Mains, Domestic Service Pipes and Fittings is essential. Applicants must also have a thorough mechanical knowledge of Meters and be capable of supervising repairs thereto. The applicant appointed will also be required to supervise all meter readings (2000 meters) and keep the meter books from which accounts are made out. He will also be responsible for the Company's staff of Waste Inspectors (now nine in number), meter readers, repairers, &c., and he will be required to reside on the Company's premises and take duty outside office hours alternately with the Company's Mains Superintendent and deal with complaints and breakdowns arising at such times. Salary £300, rising by yearly increments of £20 to £400, with house rent and rates free, less 5 per cent. annual contribution to the Company's Superannuation Fund, the joining of which is compulsory. Applications will only be considered from those with good experience in similar work, and these must be received not later than May 23rd next, and must be made on forms obtainable after May 2nd on application.—Address, 9041, The Engineer Office. 9041 A

WANTED for High-class Engineering Works in Lancashire (200 men including staff), a GENTLEMAN of strong character, of undoubted administrative ability, commercially experienced, and with engineering training, to handle correspondence and generally control staff; one with experience in Condenser and Heat Exchange Problems preferred. Good salary to right man. State age and experience. Applications treated in confidence.—Address, 9158, The Engineer Office. 9158 A

ASSISTANT to LOCOMOTIVE SUPERINTENDENT WANTED for South America. Must speak Spanish. £300 and free quarters.—Write, stating age and qualifications, E. W., c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 9170 A

ASSISTANT REQUIRED for Private Engineering College in preparation of candidates for Examinations. Applicants should possess an Engineering Degree or equivalent Diploma. Diesel engine experience an advantage.—Address, giving full particulars and stating salary required, P613, The Engineer Office. P613 A

ENGINEER REPRESENTATIVE REQUIRED for India; must have Indian experience and be familiar with Sugar Manufacture and Machinery; able to prepare estimates for plants and advise buyers; preferably unmarried. State age, experience, and salary desired.—Box No. 272, Brown's Advertising Offices, 166, Buchanan-street, Glasgow. 9028 A

GOOD SURVEYOR REQUIRED for at Least 12 months, to Revise Ordnance Sheets. Salary £4 per week.—Applications, stating age, experience, and copies of testimonials, to ENGINEER, Fylde Water Board, Blackpool. 9195 A

MECHANICAL ENGINEER WANTED as Assistant in Large Manufacturing Company; must have had both office and works experience in connection with heavy industrial machinery, conveying and other auxiliary plant. Good opening for well-trained and energetic man, 30 to 35 years of age.—Address, stating age, experience, and salary required, 9162, The Engineer Office. 9162 A

REPRESENTATIVE REQUIRED by West of England Firm for Midlands; must be first-class man with knowledge of Elevating and Conveying Machinery, with good connection amongst collieries, gasworks, power stations, &c.—Address, with full particulars, 9197, The Engineer Office. 9197 A

REQUIRED by an Old-established Engineering Firm producing light agricultural machinery and employing about 400 men, a GENERAL MANAGER to take entire charge.

Replies should give full particulars of experience with references, and should state salary required.—Address, 9156, The Engineer Office. 9156 A

SUPERVISOR WANTED, Good Organiser. Not afraid work and able push output on repetition assembling work in new growing business of patent Conveyors.

Full particulars and if commercially experienced. REDLER PATENTS (Box 44), Sharpness, Glos. P627 A

OIL ENGINES.—Progressive and Experienced YOUNG MAN WANTED, to Take Charge of Assembly, Erecting and Testing of Heavy-Oil Engines. —Address in confidence, stating fullest possible details including age, experience, and salary required, 9092, The Engineer Office. 9092 A

WANTED, First-class Experienced RAILWAY CARRIAGE DRAUGHTSMEN.—Apply by letter, stating experience and salary required, THE BIRMINGHAM RAILWAY CARRIAGE and WAGON CO., Ltd., Smethwick. 9185 A

SITUATIONS OPEN (continued)

WANTED by General Engineers, DRAUGHTSMAN experienced designing Pumping Machinery. Excellent prospects for right man.—Write, stating age, experience, and salary required, to MANAGING DIRECTOR, Avamore Pump Co., Ltd., Sicklemill Works, Haslemere, Surrey. P599 A

WANTED IMMEDIATELY, 2 DRAUGHTSMEN, aged 20-30. Sound knowledge of Steel-framed Buildings, Roofs, &c. Theoretical knowledge essential. Permanency for right men.—Apply, stating salary required and experience, to CHIEF ENGINEER, Drew-Bear, Perks and Co., Ltd., Wellington-road, Battersea. P610 A

WANTED, SENIOR DRAUGHTSMAN for Plant Layout, preferably with knowledge of Bakery Machinery and capable of controlling men.—Write, stating experience and salary required, to W. H., c/o Baker Perkins, Ltd., Peterborough. 9213 A

ASSISTANT DRAUGHTSMAN WANTED Promptly in Engineering Works, Eastern Counties, age 25 to 30; with good general mechanical engineering experience. Preferably one familiar with and competent to design throughout medium-size Stationary and Portable Steam Engines.

Address, stating age, experience, and when disengaged, 9164, The Engineer Office. 9164 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, London, S.W. 1. 8768 A

DRAUGHTSMAN (JUNIOR) REQUIRED in East Midlands, for Steam Engine and Boiler Work generally.—Write, stating age, experience, and salary required, Box 937, Sells Advertising Offices, Fleet-street, E.C. 4. 9216 A

DRAUGHTSMEN REQUIRED, One with Good general experience, and one for Jig and Tool Work. North London district.—Address, giving full particulars of experience and salary required, 9214, The Engineer Office. 9214 A

DRAUGHTSMAN, Skilled in Design and Lay-out of Mechanical Handling Plants for Ore and Coal. Men without actual experience need not apply. State age, experience and salary required.—Address, 9022, The Engineer Office. 9022 A

DRAUGHTSMAN WANTED AT ONCE, Used to Lay-out and Details of Heavy Milling Plant, Conveyors, &c. Only first-class men need apply.—Address, stating age, experience, and salary required, 9183, The Engineer Office. 9183 A

DRAUGHTSMAN WANTED, Thoroughly Experienced in the design of Colliery Electric Winding Engines and Haulage Gears (mechanical portions).—Write, stating age, experience, and salary required, Box 938, Sells Advertising Offices, Fleet-street, E.C. 4. 9215 A

HEATING and VENTILATING DRAUGHTSMAN REQUIRED IMMEDIATELY. Must be first class, thoroughly efficient in all technical and practical details. State age, experience, and salary required.—Address, 9165, The Engineer Office. 9165 A

MACHINE TOOL DRAUGHTSMAN WANTED experienced in Special Tool design.—Address, stating experience, age, and salary required, 9105, The Engineer Office. 9105 A

MECHANICAL DRAUGHTSMAN WANTED by Firm in London area, with first-class technical and shop training. Only men exceptionally well up in problems of mechanical design need apply.—Address, stating age, salary, and experience, 9037, The Engineer Office. 9037 A

STRUCTURAL DRAUGHTSMAN, Good All-round man, WANTED AT ONCE in London, accustomed to Industrial Buildings; knowledge of conveyor work an advantage. Only first-class men need apply.—Address, stating age, experience, and salary required, 9184, The Engineer Office. 9184 A

STRUCTURAL STEEL WORK. — JUNIOR DRAUGHTSMAN REQUIRED. Must be able to make accurate Shop Details. State salary and experience.—Address, P609, The Engineer Office. P609 A

BLACKSMITH FOREMAN REQUIRED for Oilfields in India, with experience of all kinds oil well tools. Accustomed to welding stems up to 6in. diameter and dressing large boring bits. Experience in oil and gas-fired furnaces a recommendation. Unmarried man preferred. Salary and Provident Fund Rupees 3900, Rs. 4550, and Rs. 5200 per annum, first to third years respectively, plus allowance Rs. 120 per month. Passage paid. Medical expenses and furnished quarters free.—Reply, giving age, full particulars of experience, and copies of testimonials, to "Z. A. 607," c/o Deacon's Advertisement Agency, 9, Fenchurch-avenue, London, E.C. 3. 9218 A

SITUATIONS WANTED

ADVERTISER (21) DESIRES POST with Some prospects; 5 yrs. D.O. and technical exp. in mech. engineering, patents, instruments, and experimental work; good technical and secondary education; A.M.J.I.E.—HUGHES, 24, Bevington-road, W. 10. P615 B

CHARTERED CIVIL ENGINEER SEEKS APPOINTMENT; experience engineers' and contractors' side, and the carrying out of work by direct labour; reinforced concrete, pile driving, roads, bridges, railways, tunnels, caisson sinking, contract plans, parliamentary surveys.—Address, P623, The Engineer Office. P623 B

ENGINEER AND WORKS MANAGER AT LIBERTY. Good all-round engineering experience, organising and administrative ability; held responsible positions as works and chief engineer and works manager; energetic and disciplinarian; highest refs.; age 37.—M. EVERTON, Coleridge-road, Ashford, Middlesex. P608 B

ENGINEER OFFERS SERVICES in Responsible position, advisory, administrative or otherwise; long experience in electrical and mechanical applications of power for industrial engineering, where maximum economy and efficiency is essential, either for new installations or existing plants requiring modification to modern conditions.—Address, P614, The Engineer Office. P614 B

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ENGINEER (28), Single, Apprenticeship Completed first-class Clyde shop, 3½ years watch keeping engineer passenger vessels, 3 years foreman plant maintenance, factory and repairs shop, thoroughly understands upkeep steam and electric plant, installation, correspondence, SEEKS SITUATION, Continent or the East. Good testimonials.—Address, P583, The Engineer Office. P583 B

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ENGINEER, Young Scotsman, 23, Desirous of going abroad, complete knowledge of Sugar Milling Machinery, WISHES SITUATION as ASSISTANT ENGINEER. Salary no object. Thoroughly qualified in the fitting and upkeep of mills. Excellent references.—Particulars from Box 75, Osborne-Peacock Co., Ltd., 82, Gordon-street, Glasgow. 9201 B

SITUATIONS WANTED (continued)

FOUNDRY MANAGER or FOREMAN DESIRES POST, of exceptional abilities, with 14 years' experience, thoroughly practical, machine tool, engine, and general castings up to 30 tons (iron and non-ferrous), expert cupola, metals, and oil sand cores, direct piecework, excellent references.—Address, P624, The Engineer Office. P624 B

GENERAL WORKS MANAGER, with Successful record in management of large engineering works (steam and internal combustion), will shortly be open to ACCEPT similar POSITION. Has extensive experience with modern works plant and organisation to ensure economical production of high-class work in large quantities. Highest references supplied.—Address in first instance, P553, The Engineer Office. P553 B

PRACTICAL ENGINEER, 11 Years Charge of Small works; all-round general experience, plant repairs, &c.—Address, P617, The Engineer Office. P617 B

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WORKS MANAGER (40), with 10 Years' Successful managerial experience on the production of steam engines of various types, up to 7000 H.P., also gas and oil engines, air compressors, pumps, cranes, mill machinery and structural work, DESIRES CHANGE, and is open to negotiate with a progressive company with a view to appointment.—Address, P606, The Engineer Office. P606 B

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ENGINEER DRAUGHTSMAN (26) WISHES POST with plenty hard work attached, abroad, preferably in S. America. Excellent experience; shops, machine and fitting, erection; general D.O. routine, design, estimates. Moreover, has good knowledge of Spanish and is of steady and conscientious habits.—Address, P628, The Engineer Office. P628 B

FIRST-CLASS TRACER and PENMAN, Engineer's or architect's office, moderate salary, DISENGAGED.—W. G. T., 311, Queen's-road, Battersea Park, S.W. 8. 9186 B

LADY TRACER DESIRES CHANGE; 7 Years' first-class experience on principal work with noted firm. Electrical, steam, and general engineering, plant and constructional; neat and accurate; excellent references.—Address, P625, The Engineer Office. P625 B

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IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
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BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
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Established over 70 years.

PARTNERSHIP OR AMALGAMATION.—Scottish ENGINEERING BUSINESS REQUIRES PARTNER with capital or amalgamation with existing first-class firm. Contractors to Admiralty, War Office, Crown Agents, Indian Office, foreign and colonial Governments and corporations. This is a very old business with a splendid record. High-class contracts on hand.—Address, "CONTRACTORS," Wm. Porteous and Co., Advertising Agents, Glasgow. P575 C

PARTNERSHIP.—IRONFOUNDRY, Old-established with good connection, thoroughly equipped for high-class work, loam, dry sand and green sand. PARTNER REQUIRED with capital. This is a first-class proposition to those interested.—Address, "IRON," Wm. Porteous and Co., Glasgow P576 C

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AGENCIES

AGENTS REQUIRED for Australia and Egypt by Oil Engine Manufacturers of world-wide reputation. Only reputable firms need trouble to apply.—Kindly write, fully stating facilities for storage, erection, &c., to 9166, The Engineer Office. 9166 D

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AGENCY WANTED by Well-established Iron Merchants having a sound connection among steamship companies, engineers and mills. Liverpool district and North Wales. Only first-class agency considered.—Address, 9060, The Engineer Office 9060 D

A.M.I.C.E., A.M.I. Mech. E., with 20 Years' Practical experience in general mechanical engineering and 2 years' sales experience, DESIRES to REPRESENT GO-AHEAD FIRM, on a salary and commission basis. Has good connection in Yorkshire and Lancs.—Address, P598, The Engineer Office. P598 D

LONDON REPRESENTATIVE.

TO MANUFACTURERS Who May be Contemplating closing their own London offices and those not hitherto represented in London, an experienced CIVIL and MECHANICAL ENGINEER, M.INST.C.E., M.I.MECH.E., with commercial experience and offices in West-minster, and who is well known to all the principal consulting engineers and other important buying agencies and the big contracting firms, OFFERS his SERVICES as LONDON REPRESENTATIVE—Address, P619, The Engineer Office. P619 D

REPRESENTATIVES WANTED by Old-established Firm of Engineers and Ironfounders, makers of special machinery and general engineering and light castings. Preference given to those already covering London, Manchester, Sheffield, or South Wales Districts for non-competitive firms.—Address, 9194, The Engineer Office. 9194 D

COMPANY MEETING

The English Electric Company, Ltd.

ANNUAL MEETING OF SHAREHOLDERS, 13.5.1925.

SIR CHARLES ELLIS, Chairman of the Company, who presided at the Annual General Meeting on May 13th, said that they met in the shadow of a great and unexpected loss in the death of Mr. John Sampson. He was a symbol of wisdom and stability and enjoyed not merely the friendship, but the affection of those who worked with him.

The net profit of £263,780 for the year was slightly in excess of that shown in the previous year. The 8 per cent. Notes had disappeared and were replaced by 6 per cent. Convertible Debentures. This successful financial operation meant a reduction of £12,324 in the debenture interest charges of the Company and its subsidiaries. Next year they would receive a consolidated balance sheet of the entire group as one unit.

During 1924 the volume of orders secured by the Company was greater than in any year since its formation. In the home market symptoms of a lull in large-scale electrical development had appeared, but this could only be temporary with so large a part of the population still inadequately served with electricity. Abroad there were few markets in which the Company had been unable to find a sale for its products in world competition. They were confident that the strong position which they had built up in the export trade could be maintained and strengthened. In meeting foreign competition the Company had been assisted by the absence of any serious trade dispute and by the loyal co-operation of all the workers in their employ.

Electric traction was again in the front of their activities. Electrical equipments ordered for their suburban lines running out of Bombay by the Great Indian Peninsula Railway were now in operation. Before the summer was out most of the material for the electrification of the South-Eastern section of the Southern Railway would be in commercial service. Heavy electric locomotives had been supplied to the Montreal Harbour Board and the Japanese Government Railways, and the Company obtained the contract for the whole of the electrical equipments required for the electrification of the suburban lines of the South African Railways in and around Cape Town.

Steam turbines and water turbines of the largest sizes with the electrical generators driven by them were on order for Poland, Japan, Australia, India, Canada, and South Africa. The Fullagar internal combustion engine which they had developed for land purposes was now in commercial service all over the world. The universal development of electrical generating stations necessarily brought in its train a great demand for their standard industrial plant and its apparatus.

Sir Charles Ellis referred to their co-operative activities through the Power and Traction Finance Company and in particular to the Lanarkshire Hydro-Electric Power Act promoted last year by that Company for the development of the Falls of the Clyde. In agreement with the Clyde Valley Company, in whose area the falls were situated, they were now carrying out extensive hydro-electric works. These, when completed, would provide the Company with the first model hydro-electric installation on a large scale to be constructed in this country entirely to British design and by British manufacturers.

Another co-operative enterprise in which they were interested was the Sudan Light and Power Company, which was carrying out important extensions in the electricity and water supply and transport services in Khartoum and Omdurman.

The business of the Company rested on the solid foundations of technical and manufacturing achievement, and in that lay the surest guarantee of the future. 9189

BUSINESSES and PREMISES (For Sale, etc.).

ENGINEERING SHOP and FOUNDRY, Small and well-equipped, complete with lighting and power; extremely low rental; N.W. London; low price for quick sale.—Address, P605, The Engineer Office. P605 L

FOR SALE, as a GOING CONCERN, by PRIVATE TREATY, MOORE PARK BOILER WORKS, HELEN-STREET, GOVAN, GLASGOW, formerly owned by Lindsay Burnet and Co., latterly the property of the Forth Shipbuilding and Engineering Co., Ltd. (in liquidation).

The works were established in 1883, are still working, and are conveniently situated both to the river Clyde and to railway connections, having a siding into the works from L.M. and S. Railway.

Ground area, Freehold, 9231 square yards, or thereby.

Works well equipped with plant, machinery, tools, &c., for all classes of boilers, and with hydraulic, pneumatic and electrical installations.

Early possession can be given.

For further particulars, apply to SECRETARY, the Forth Shipbuilding and Engineering Co. (1921), Ltd., 20, Great St. Helens, London, E.C. 3; to Messrs. McCLELLAND, KER and CO., 115, St. Vincent-street, Glasgow. 9084 L

EASTWOOD, SWINGLER and CO., Ltd. (in Voluntary Liquidation), BRIDGE BUILDERS AND CONSTRUCTION ENGINEERS, VICTORIA AND RAILWAY IRONWORKS, LITCHURCH, DERBY.

FOR SALE as a GOING CONCERN.

The HIGHLY IMPORTANT, EXTENSIVE and VALUABLE FREEHOLD WORKS, having a frontage of 229 yds. on the Osmaston-road and a line of sidings extending to a depth of 725 yds. or thereabouts on the L.M. and S. Rly. main line between Birmingham and Derby.

The WORKS consist of the following departments:

(a) TOP MILL DEPARTMENT, comprising main roof in three spans, weigh house, wood sheds, roll turning shop with 10in. and 20in. reversing mill, test house, millwrights' shop, workmen's messroom and time and general offices, and VALUABLE ENGINEERS' FIXED PLANT, MACHINERY, LOOSE TOOLS, with puddling, ball and heating furnaces and other general equipment.

(b) FOUNDRY FITTING and POINTS and CROSSINGS DEPARTMENT, comprising foundries, brick built, fronting railway, with all complementary shops, stores, offices and relative PLANT and MACHINERY.

(c) GIRDER DEPARTMENT, under three-span roof, fitted with Overhead Electric Cranes, Drilling, Planing and Pneumatic Riveting Machines, and all other necessary Machinery, Stores and Offices.

Electric power is supplied throughout the works with gas engines in reserve.

For further particulars and cards to view apply to the Receivers and Liquidators,

WILLIAM CAMPION, 25, Iron Gate, Derby.
CHARLES J. PAIN, Chartered Accountant, 18, Low Pavement, Nottingham, and Atlantic House, Holborn-viaduct, London, E.C. 1. 9046 L

FOR HIRE

FOR HIRE, PUMPS and WELL-BORING TOOLS for Contractors' Deep Wells, &c., 2in. to 24in. dia.—R. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 978 Hop. 822 K

FOR SALE or HIRE, ELECTRIC MOTORS, from 60 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. T. WILLIAMS and SONS, 37, Queen Victoria-street, London, E.C. Tel., City 3938 Ex.

For continuation of Small Advertisements see page 3.

A Seven-Day Journal

Static Electricity and Petrol.

THE annual report for the year 1924 of his Majesty's Inspectors of Explosives, issued last week, contains some important remarks regarding the danger of static electrical discharges when a tank wagon or even the tank of a motor car is being filled with petrol. Following upon a fatal accident at the Shell-Mex works at Shell Haven last August, a series of experiments was carried out by a firm of consulting engineers, and the results were confirmed by the company's chief chemist. It was demonstrated that when any grade of spirit or paraffin is pumped through pipe lines static electricity is produced by the friction of the spirit against the pipe walls. If the vessel into which the spirit is pumped be insulated—as, for example, by the rubber tires of the motor vehicle of which it forms a part—charges capable of giving measurable sparks may readily accumulate on it. The amount of electricity generated is practically independent of the grade of fuel being pumped, but increases with the length of time and the speed of pumping, and is considerably increased if the end of the delivery pipe is fitted with a rubber hose. The charge is not materially affected by the length of the delivery pipe, by the hygrometric state of the atmosphere, or by the presence of water in the spirit. It would appear that the most important influence is the speed of pumping. Below a certain critical velocity no electrical effect at all could be observed. On the other hand, electrical effects were easily observed at velocities well within the range of those that are customary in ordinary everyday work. Since the explosion at Shell Haven last August the company has issued strict rules to govern filling operations, among which is one requiring the vehicle to be earthed by a chain provided for the purpose before any detail of the filling operation is begun. Since the investigations referred to were conducted information has been received of a fatal fire in the United States produced by a static electrical discharge during the filling of the tank of a Ford motor car.

Wembley.

ON Saturday last, May 9th, the British Empire Exhibition opened its gates once more to the public. Outwardly it is not a very different Exhibition from that of last year; it still lacks pictorial charm, and its promising vistas are still blocked by ugly little kiosks; the silent grey of its concrete has not been mellowed by a dripping winter, and the little lion which provoked such mirth in the House of Commons a few nights ago still keeps his tail down as if he feared that the Clerk of the Weather had not yet put away his whip. The roads are a little bit better, and an economical effort to lend dignity to at least one of the entrances has been made. But internally there is one notable change. The Palace of Engineering is no more. The husk remains, it is true, but is now named the Palace of Housing and Transport. Within, the long unlovely aisles are almost destitute of the products which stand for the greatest industries of the United Kingdom. Here and there are a few locomotives and carriages and a few motor cars, more American than British, and here and there are dotted about little houses which look as if they had stepped into that vast building to await the reopening of the Exhibition which gives them their proper environment. For the rest there are stalls where you may buy patent spanners, lock-nuts, and golliwogs, and others which we suspect will prove to be no more than minor shops, are being erected. In the whole Exhibition we found little or nothing that will appeal to the engineer; whether it will be any the less popular remains to be seen. In any case it is significant that a large area has been taken out of the old Palace of Engineering for a restaurant and another area has been stolen from the Palace of Industry for the same purpose.

The Oscillation Nuisance.

EVER since the introduction of broadcasting the problem of finding ways and means of stopping oscillation has been under consideration. Many users of wireless receivers provided with reaction seem to be quite incapable of realising that these sets can easily be made to radiate energy and to interfere with the reception of others. At one time the Post Office specified that the reaction coil must not be coupled to the aerial coil, but apparently it was realised that the regulation could not be enforced and it was abandoned. In any case the elimination of this form of coupling does not necessarily remove the trouble. The question of oscillation and how to prevent it was recently discussed at a meeting of the executive of the Radio Association, held in the House of Commons under the presidency of Lieutenant-Commander Kenworthy. It was pointed out that the executive had received information to the effect that, owing to the increase of oscillation, the Post Office had in view drastic steps with regard to the use of reaction in wireless sets. It was decided that a strong campaign against the oscillation nuisance should be instituted without delay, and Professor A. M. Low and Mr. Alexander W. Sharman both mentioned that with the assistance of improved direction finding apparatus a special plan of operation against users of receivers with reaction had been worked out. With motor cars equipped with this apparatus it was stated definite information of persistent offenders could be obtained, and it was proposed to institute a test case against one or more of them. It is to be hoped that the scheme will prove successful, but in the past, we believe, tests with direction finding apparatus on motor cars have not led to very satisfactory results. In fact, we remember hearing of an experiment of this nature which led to the conclusion that the offending party was situated in the middle of a wood.

A Corrugated Motor Ship.

IN view of the heated discussion on the propulsive performance of the corrugated or Monitor type of ship which took place at the recent meetings of the Institution of Naval Architects, it is noteworthy that a new ship of this type, the first of its kind to be built on the Clyde, was launched from the yard of David and William Henderson and Co., Ltd., Glasgow, on Friday, the 8th inst. The River Ottawa, as the vessel is named, is a motor ship built to the order of Peterson and Co., Ltd., London, who are well-known owners of corrugated steamships. She is of the shelter deck type and her decks and double bottom have been built on the Millar system. The following are some particulars of her hull and machinery:—Length between perpendiculars, 400ft.; breadth moulded, 55ft. 6in.; depth moulded to shelter deck, 37ft. 9in.; measurement about 5200 tons gross. Her propelling machinery will consist of a single Harland and Wolff-Burmeister and Wain marine oil engine designed to develop 1850 brake horse-power at a normal speed of 90 revolutions per minute. Both engine-room and deck auxiliaries will be electrically operated. Up to the present the corrugated system has mainly been tested on cargo steamers of full form. The propulsive performance of the new motor ship will therefore be awaited with special interest.

The Minerals of the Dead Sea.

IT is officially announced that, acting through the Crown Agents for the Colonies in London, the Palestine Government is prepared to receive tenders for the exploitation of the mineral resources of the Dead Sea. The strong brine of which the waters of that sea are composed is said to contain about 25 per cent. of dissolved salts, of which 4 to 7 per cent. is potassium chloride. It is estimated that the sea contains altogether about 1500 million tons of potassium chloride, so that Palestine may yet come to be regarded as one of the richest potash-bearing countries in the world. It remains to develop a satisfactory method of recovering the potash from its admixture with sodium, magnesium and other salts. Preliminary investigations in this connection would seem to have yielded promising results. In addition to the salts in the brine, there are said to be commercial possibilities in the development of some phosphate and bituminous limestone deposits in the region of the Dead Sea. In connection with this report it may be mentioned that in a paper read before the Royal Geographical Society on Monday, Mr. H. St. J. B. Philby discussed the oft-debated question as to why the Dead Sea is salt. The latest belief is that the salts are supplied to it from the river Jordan, and that that river obtains its salts from certain springs at Tiberias on the Lake of Galilee. Mr. Philby stated that 30 per cent. of the salinity of the Dead Sea is accounted for by sodium chloride and 70 per cent. by magnesium chloride. Curiously enough, he did not mention the presence of any potassium salt.

Wages in the Engineering Industry.

ON Wednesday of next week, May 20th, the representatives of the various unions connected with the engineering industry are to meet for the purpose of considering their reply to the employers' proposals regarding wages and conditions of working submitted to them on April 23rd. The employers, in response to the men's demand for an all-round advance of 20s. per week, offered to increase the present war bonus by 2s., but accompanied that offer with a suggested increase in working hours and a decrease in the extra allowances for overtime and night shift work. Among the unions feeling is, we learn, turning against the acceptance of the employers' proposal. It is being argued that by making it easier for the employers to increase overtime working by reducing the extra allowance paid for it and also by lengthening the working week the chances of the unemployed members of the unions securing work will be still further reduced. Attention is also being focussed on the employers' suggestion that "the claim by any class of workpeople to an exclusive right to any operation or particular job" requires relaxation. It is argued that such a proposal, if conceded, would give the employers the right to place any workman on any class of work and that apprentices trained to a particular trade would have no assurance that they would be allowed to follow it. On a very fundamental matter, the virtues of the present method of national negotiations, opinion among the unions seems to be divided. While some of the men's leaders continue to favour it, others are suggesting that as all branches of the engineering industry are rarely busy at the same time, local negotiations would secure a result more favourable to many of the men in that those connected with a prosperous section would not be penalised by the withholding of an increase in wages on the ground that all sections of the industry were not equally well able to grant it.

The St. Lawrence Deep Water Project.

FOR some considerable time the people and Government of the United States have been anxious to improve the facilities for shipping grain and other produce from the States bordering the Great Lakes. At present much, if not the bulk, of that produce is carried down the St. Lawrence through Canadian territory, with the result that transport is restricted. By the construction of lateral canals and other works it has been proposed to provide a deep-water communication from the Lakes to the sea, but the Canadian people have been slow to agree with such a scheme, partly on the ground that it would probably deprive the lower portions of the river of a certain amount of water and partly no doubt because they believe that increased facilities for the shipment of agricultural produce from the States would react unfavourably on their own industry. News has now been received that after prolonged negotiations the two Governments have at length agreed to a joint official investigation of the project. The engineering features are to be thoroughly studied, as well as the total cost of the scheme, the amount of power incidentally to be developed by it, and the effect on the natural water level of the river produced by the diversion of water from the Great Lakes. Simultaneously with the investigation of the scheme a study will be made by United States engineers of the practicability, cost and operating expenses of a deep-water project to connect the Great Lakes with the Hudson River. It is anticipated that both investigations will be completed in about twelve months' time, and that on their results it will be possible to determine national policies in a final manner.

The Shipbuilding Trades Investigation.

THE second meeting of the joint committee of shipbuilding employers and the shipyard trade unions took place at Edinburgh on Tuesday. The proceedings were again conducted in private, but an announcement was subsequently made concerning certain correspondence which had taken place between the joint committee and the Prime Minister. In a letter to Mr. Baldwin the purpose of the investigation was outlined and the assistance and co-operation of Government Departments was asked for in the work of analysing the real causes of the difficulties which militate against effective competition in the world's markets for shipbuilding and ship-repairing orders. In his reply the Prime Minister assured the committee that the Government Departments would give the best assistance possible, and would be ready to help with any information in their possession. We understand that a further meeting of the joint committee is to be arranged at an early date.

The American Naval Manœuvres.

THE American fleet manœuvres now taking place off Hawaii are said to have demonstrated the vulnerability of those important islands to invasion and capture unless their present defences are greatly improved. So far as can be gathered from Press reports, the attacking fleet engaged in the recent operations was in overwhelming force, and the only floating defences at Oahu—the principal island of the group—consisted of submarines. It would appear, therefore, that the real object in view was to test the efficiency of the coast artillery mounted on the island, and not to work out a problem of purely naval strategy. The fact that Honolulu, the capital of Hawaii, and Pearl Harbour, the great naval station, are both situated at Oahu explains the desire of the American Government to render the island impregnable. Details of the ordnance now in position there have been freely published in American service journals. The heaviest weapon is apparently a 9in. howitzer, which can either be used as a stationary piece or mounted on a railway carriage for mobile defence. Then there are howitzers of lighter calibre and a number of 155 mm. high-velocity guns. The military authorities state that at least four 16in. guns must be mounted at Oahu if the island is to be made safe from naval attack. They further recommend the dredging of a deeper channel through the coral reef to give improved access to Pearl Harbour and the building of new strategic roads. It is proposed to raise the strength of the garrison from 14,000 to 25,000. In view of the fact that Hawaii is 3370 miles from the coastline of a possible enemy, we should have imagined that its surest form of defence from attack would have been the existence of an American "fleet in being."

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. XX.*

PERIOD 1860 TO 1865.

BETWEEN 1860 and 1865 the existing locomotive types were enlarged and improved, but only one or two new types were introduced. The most notable advance was in reality due to the steel maker, and we now meet with a rapidly extending use of steel tires and axles, and even tentative trials of steel boilers and fire-boxes. But although many of the locomotive engineers of that day almost immediately adopted steel tires, they were much more cautious when crank axles, and more especially steel boilers were concerned, and it was at least twenty years later before steel could be said to have gained the victory over Low Moor or Farnley iron. In addition to employing stronger material, the locomotive engineer was also endeavouring to design various methods of making his engines more flexible on curves. Injectors, screw-reversing gears, and the Ramsbotton tender water pick-up apparatus were also products of this period. These, together with other improvements in details will be considered at the end of this section, after the more notable locomotives of the day have been described.

2–2–2 *Express Engines—Outside Cylinders.*—At the end of 1859 Benjamin Connor built the first of the Caledonian "8ft." single engines at the company's works at St. Rollox. In all twelve were constructed there between 1859 and 1865, and four more in 1875.

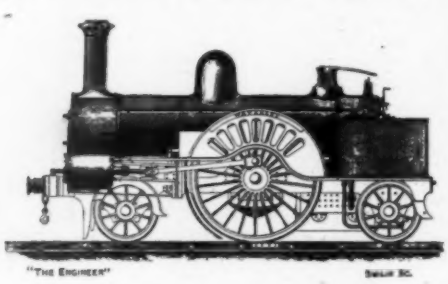


FIG. 149—L. AND N.W. RAILWAY ENGINE, 1859

There were also three exported by Neilson and Co. to Egypt, one of which was shown in the London Exhibition of 1862. One of these as originally built was illustrated in THE ENGINEER of December 1st, 1922, page 580.

The type was a direct derivative of the Allan "Crewe" engine with outside bearings for the carrying axles, and cylinders placed between the outside and inside frames. The large size of the driving wheels, 8ft. 2in., allowed the 17½in. by 24in. cylinders to be placed horizontally, and in this respect the engines differed from the "Crewe" type, which had inclined cylinders. The general dimensions of this and other single express engines are given in the annexed table. The centre of the boiler was 6ft. 6¾in. above rail level, some reduction in height being obtained by using Gooch's stationary link motion. The tires were of Krupp steel, and the driving axles of cast steel, made, according to Clark, at St. Rollox works. Incidentally it may be added that a large number of these straight driving axles broke in service; they were 6½in. diameter throughout except at the journals, which were concave, and the wheel seats were also 6½in. diameter. But whether the material or the dimensions were faulty has not been recorded. The driving wheels had crescent-shaped balance weights forged solid with the rims, and, as far as the writer can trace, these were the first examples of this construction. In Colburn's "Locomotive Engineering" D. K. Clark stated that the valves had 1¼in. laps and long travel for the special purpose of obtaining a free exhaust at high speed from the exposed outside cylinders, in which steam wes liable to condensation, and therefore more sluggish in leaving the cylinders. This was in accordance with R. Sinclair's practice. The engines were provided with cabs, injectors, and with brick arches and deflectors for coal burning. The weight—14 tons 11 cwt.—on the driving wheels was very heavy for the period. These engines rendered excellent service and worked the West Coast Scotch expresses between Carlisle and Glasgow and Edinburgh until 1883–4, when D. Drummond replaced them on the heaviest trains by coupled engines. In their rebuilt condition they were as shown in Fig. 147, with flush boiler, on the middle of which the dome was placed. As originally built the dome was on the fire-box casing, which was raised above the barrel.

The London and North-Western engines of the "Problem" or "Lady of the Lake" class—Fig. 149—by J. Ramsbottom, were contemporaries of the Caledonian engines, and were also built from the end of 1859 to the middle of 1865, though, being sixty in number, were much more numerous. They were much lighter engines, with cylinders 16in. by 24in., 6ft. between centres, and driving wheels 7ft. 7½in. diameter, with only 11¼ tons on them. Unlike all preceding Crewe designs the carrying wheels had inside bearings only. To place the leading axle sufficiently far forward the cylinders were inclined, but nevertheless the wheel base, as in the case of the Caledonian and Great Eastern outside cylinder engines, was somewhat short. The writer frequently observed the running of the "Lady of the Lake" class from the platforms of wayside stations, and noticed that the engines swayed or "nosed" from side to side. The unbalanced portions of the reciprocating masses affected these light outside cylinder engines to a considerable extent, and the effect was aggravated by the external action between the rails and the flanges of engines with short wheel base. In most respects they were simple straightforward engines and presented several features of interest. The boiler was telescopic and pitched with centre 6ft. 7in. above the rails. The smoke-box was provided with an ash hopper, an arrangement initiated by Ramsbottom and used on most of the L and N.W.R. engines until the end of F. W. Webb's superintendency. Horizontal screw reversing gear was fitted, the nut being connected to the reversing rod by a lever pivoted near the centre. The cylinders and valves were lubricated by means of condensation lubricators, and the 50 engines built from November, 1860, had Giffard's injectors, whilst the first ten were built with crosshead pumps.

Between 1895 and 1899 F. W. Webb rebuilt all these engines. The new boilers, which had somewhat larger fire-boxes, were raised about 3in., and the pressure was increased to 150 lb. The diameter of the driving wheels with thicker tires became 7ft. 9in., and volute springs replaced the plate springs under the driving axle. The weight was increased to 31 tons 7 cwt., of which 14 tons 5 cwt. was available for adhesion. About ten years later all were broken up. In their latest condition they were illustrated in THE ENGINEER, December 25th, 1896, and April 16th, 1897.

Robert Sinclair's Great Eastern express engines with outside cylinders—Fig. 148—were built by Fairbairn, Kitson, the Avonside Company, and Schneider (Creusot) between 1862 and 1867. In them we again find the Allan "Crewe" type. The cylinders were 16in. by 24in. and the driving wheels 7ft. 1in. diameter. Other leading dimensions are given in the table. They had many features in common with the Caledonian engines, *e.g.*, the boiler barrels were parallel with circumferential butt strips, and Gooch's valve gear was employed. The weight on the leading axle was carried by a transverse plate spring, with the addition of a light longitudinal plate spring above each journal. Screw reversing gear was fitted. These engines worked the fastest main line expresses for more than twenty-five years.

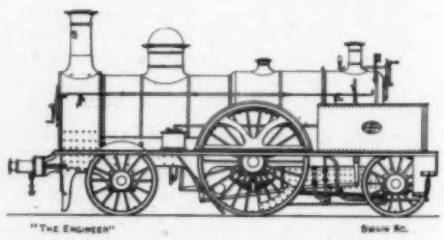


FIG. 150—L. AND N.W. RAILWAY ENGINE, 1861

It will be noticed that the celebrated French firm of Schneider et Cie appears amongst the makers of these engines, of which they built six in 1866–7, the last being shown in the Paris Exhibition of 1867. At the same time they also constructed ten 2–4–0 engines for the Great Eastern. These were the first orders for locomotives for home railways which had been

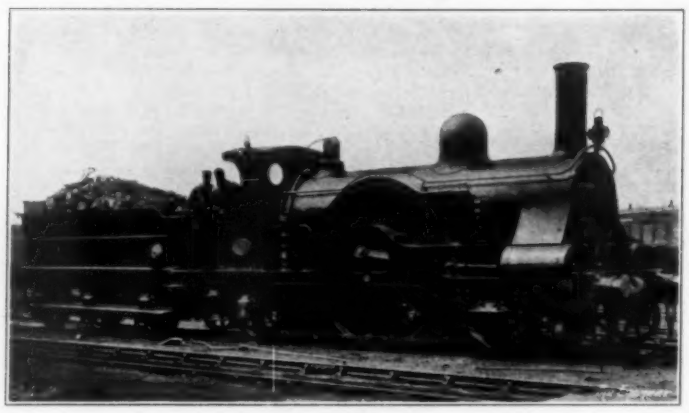


FIG. 147—CONNOR'S LOCOMOTIVE, 1859—RE-BUILT

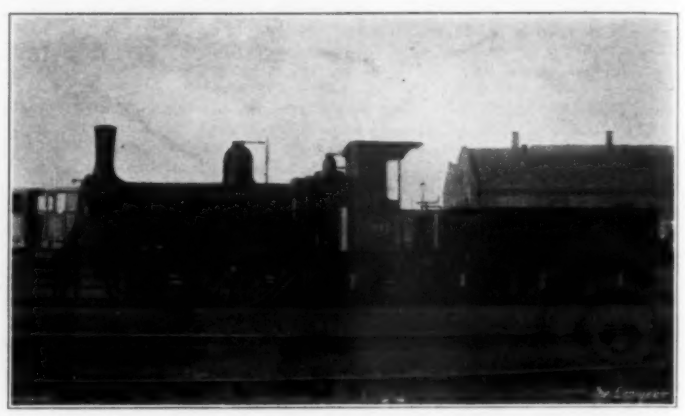


FIG. 148—GREAT EASTERN EXPRESS ENGINE, 1862

Single Express Engines, 1860 to 1865 Period.

	Railway.	Designer.	Date.	Cylinders.	Driving wheels.	Carrying wheels.	Wheel base.	Tubes	Heating surface. Tubes.	Heating surface. Fire-box.	Heating surface. Total.	Grate area.	Pressure.	Weight on driving wheels. t. c.	Total weight loaded. t. c.
1	C.R.	Connor	End of 1859	17½″ × 24″ outs.	8′ 2″	3′ 8″	7′ 2″ + 8′ 6″ = 15′ 8″	192 1¾″	1080	89	1169	13.9	120	14 11	30 13
2	L.N.W.R. (N.D.)	Ramsbottom	Do.	16″ × 24″ outs.	7′ 7½″	3′ 7½″	7′ 7″ + 7′ 10″ = 15′ 5″	192 1¾″	1013	85	1098	14.9	120	11 10	27 0
3	G.E.R.	Sinclair	1862	16″ × 24″ outs.	7′ 1″	3′ 7″	7′ 0″ + 8′ 0″ = 15′ 0″	190 1¾″	969	82.3	1051.3	15.7	120	11 7¼	29 5½
4	L.N.W.R. (S.D.)	McConnell	1861	18″ × 24″	7′ 7½″	4′ 6″	8′ 6″ + 9′ 6″ = 18′ 0″	214 1¾″	980.3	242.5	1222.8	25	150	14 6	34 14
5	G.N.R.	Sturrock	1860	17″ × 22″	7′ 0″	4′ 3″	9′ 6″ + 8′ 6″ = 18′ 0″	164 2″	883.6	177	1060.6		150	13 7	34 12
6	G.W.R.	D. Gooch	1862	16″ × 24″	7′ 0″	4′ 0″	8′ 0″ + 8′ 0″ = 16′ 0″	187 2″	1126	122	1248	14.6	130	12 16½	29 16
7	S.E.R.	Cudworth	1861	17″ × 22″	7′ 0″	4′ 9½″ 4′ 0″	8′ 6″ + 8′ 9″ = 17′ 3″	170 4 1½″ 2″	974.9	163	1137.9	21.2	130	12 12	33 2
8	M.R.	M. Kirtley	1864	16½″ × 22″	6′ 8″	4′ 2″	8′ 0″ + 8′ 0″ = 16′ 0″	2″			1136	16	140		

Nos. 1, 2 and 3 outside cylinders; Nos. 1 and 3 mixed frames; No. 2 inside frames; No. 4 inside frames; Nos. 5 and 6 double sandwich frames; Nos. 7 and 8 double plate frames.

* No. XIX. appeared May 8th.

placed outside this country since the American Norris engines of 1840, the reason being that British firms were then too fully employed to be able to give quick delivery.

2–2–2 *Express Engines with Inside Cylinders.*—Of the type with inside bearings for all wheels, three remarkable engines—Fig. 150—were built at Wolverton in 1861 for the southern division of the L. and N.W.R. They were the last express engines designed by J. E. McConnell before his retirement in 1862 from the position of locomotive superintendent. One was shown in the London 1862 Exhibition, together with Ramsbottom's "Lady of the Lake," to which it offered a complete contrast. The outside framed design of the 1852 engines—Fig. 88, *ante*—was discarded for the simple inside plate frame of the "Bloomers," and to clear the crank axle the boiler centre was pitched

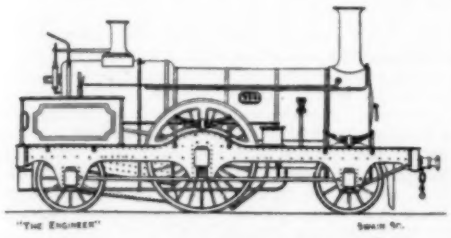


FIG. 151—GREAT NORTHERN ENGINE, 1861

7ft. 5½in. above rail level, or about 9in. higher than in any other engine of that day. The boiler was provided with McConnell's combustion chamber, which was not quite so long as that of the previous engines, and allowed a tube length of 9ft. 4in. The fire-box had a longitudinal partition. The great length of wheel base—18ft.—should be noted.

These engines met with a considerable amount of hostile criticism, very much of which was unfair. Clark[1] wrote: "The great height of the centre of the boiler, 7ft. 5½in., is excessive, and tells upon the rails when the engine sways. In the 'Lady of the Lake,' though she has driving wheels as large, the centre is 11in. lower, and thus in conjunction with a compact wheel base and a balanced driving wheel, produces a safe, steady and easy running engine." Now, the McConnell engines, with their inside cylinders, were

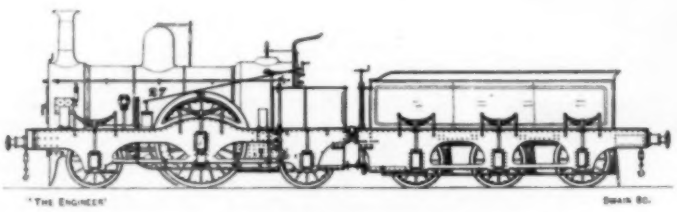


FIG. 152—MIDLAND ENGINE, 1865

also balanced, and rolled rather than swayed. But the rolling, which was not excessive, was taken up by the springs, and did not act against the rails in the way in which the short jerky lateral "nosing" of the "Lady of the Lake" class mentioned previously certainly did. Moreover, when running at high speed on a straight road, such as the L. and N.W. main line, the steadying action of the 18ft. wheel base was a great advantage over the short 15ft. 5in. base of the Crewe engine. In 1874 coupled engines were built at Crewe works with wheel base 15ft. 8in., considerably less than that of McConnell's engines, though the boiler centre was 7ft. 4½in. above rails, or only ½in. lower. P. Stirling's inside cylinder 2–2–2 engine of which of the two they preferred. It was not the Crewe engines, and they were fairly unanimous on the subject.

In Colburn, page 258, is given a comparative table of coal consumptions of the two types of 7ft. 6in. singles from particulars supplied from Crewe. The "McConnells" burnt 41.68 lb. per mile, with trains averaging 11.7 vehicles, or 99.56 tons, and the "Lady of the Lake" class consumed 26.77 lb. per mile, with 8.58 vehicles, or 72.93 tons. But neither speeds nor gradients were mentioned. The "McConnells" were working the heavier and faster express trains

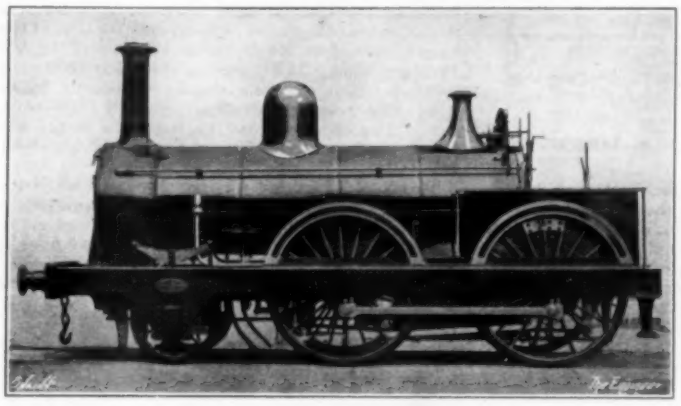


FIG. 153—BEYER PEACOCK LOCOMOTIVE, 1862

over the London–Rugby section, and the "Ladies" mostly the light Irish mails between Stafford and Holyhead, an easier road for most of the distance, so that no proper comparison can be made. But although the conditions told against the "McConnells," there is no doubt that with light trains up to about 80 or 90 tons the "Lady of the Lake" class were more economical, in addition to which the repairs to their boilers must have been less.

The engines numbered 5 to 8 in the table had double frames, with outside bearings for all axles. The wheel base of Sturrock's Great Northern engine—Fig. 151—18ft. in length, and the position of the leading axle under the middle of the smoke-box, may be noticed. The placing of this axle well forward was also continued during P. Stirling's time. Both the G.N.R. and D. Gooch's G.W.R. standard gauge express engines had sandwich frames, though of different designs. Perhaps the most remarkable thing in connection with Gooch's standard gauge engines of the 1862–1864 period was the employment of the Stephenson link motion, whilst McConnell, Sinclair and Connor in many of their contemporary express engines used Gooch's valve gear. A possible reason for this difference was that Joseph Armstrong, who then had charge of all the G.W.R. standard gauge engines at Wolverhampton, exercised considerable influence.

Cudworth's engine with double plate frames was illustrated in THE ENGINEER, November 23rd, 1923.[2] This class had the double fire-box with long sloping grate. The Midland engines are shown in Fig. 152, and the design of slotted-out plate frame, with solid tension members, may be compared with the much date than other main lines, always employed coupled engines. The outside frames were of iron plates, and Cudworth's long sloping fire-boxes were used, but without the longitudinal partition and double fire-doors. Cylinders, 16½in. by 22in.; wheel base, 14ft. 3in. in the earlier and 14ft. 9in. in the later engines; heating surface, 1065 + 82 = 1147 square feet; grate area, 19.9 square feet; pressure, 120 lb.; the weight empty was 31 tons 18 cwt., of which 21 tons 2 cwt. were carried by the coupled wheels. The arrangement of the balance weights was peculiar, those in the trailing wheels not only being larger than those in the driving wheels, but also placed on the same side as the outside cranks. In the subsequent engines of 1865 for the same railway, the usual sizes and positions of balance weights were adopted.

The Gooch standard gauge coupled engines, of which eight were built in 1862 by G. England and Co., were used on the northern division of the G.W.R. between Wolverhampton and Chester, where speeds were only moderate. They had the perforated type of sandwich frame, so long associated with the Great Western. Cylinders, 16in. by 24in.; wheels, 4ft. and 6ft. 6in.; wheel base, 16ft., equally divided. The boiler contained 195 2in. tubes, which gave a heating surface of 1091 square feet; total heating surface, 1200.8 square feet. These were the only 6ft. 6in. coupled engines on the G.W.R. standard gauge until 1873, and though of Gooch's design, had Stephenson's link motion. Long "open plate" springs were fitted.

After Joseph Beattie, Edward Fletcher on the North-Eastern Railway was the next engineer to abandon "single" engines completely. Until 1863 the East Coast expresses were worked by 6ft. 6in. single engines, and subsequently by coupled engines. An express engine of 1865 by R. and W. Hawthorn to Fletcher's design had inside bearings only for the coupled wheels, and outside for the leading wheels. The axle guards for the latter were bolted on, and Fletcher did not discard this old-fashioned design until 1870. Cylinders, 16in. by 22in.; wheels, 4ft. 6in. and 6ft. 6in.; wheel base, 16ft., equally divided; heating surface, 1085 + 98 = 1183 square feet; weight in working order, 34 tons 5 cwt., of which the driving wheels carried 13 tons 17 cwt., and the trailing wheels 10 tons.

A standard 6ft. coupled passenger engine by Beyer, Peacock and Co., 1862, is shown in Fig. 153. It is characterised by the extreme neatness and symmetry of design. Six of these engines were built for the West Midland Railway (later G.W.R.), and others were sent abroad. The cylinders were 16in. by 20in.; total heating surface, 1035 square feet; weight loaded, 27 tons. The frames were in one piece from end to end, a design much preferable to the type with bolted on axle guards.

Passenger Engines with Leading Bogies.—A few interesting types with leading bogies made their appearance on British railways during the 1860 to 1865 period. Most of them were designed and built by Messrs. Stephenson, and perhaps it was in accordance with the fitness of events that six of them were for the Stockton and Darlington Railway. The first type consisted of two engines—Fig. 154—built

FIG. 154—STEPHENSON'S ENGINE FOR THE S. AND D. RAILWAY, 1860

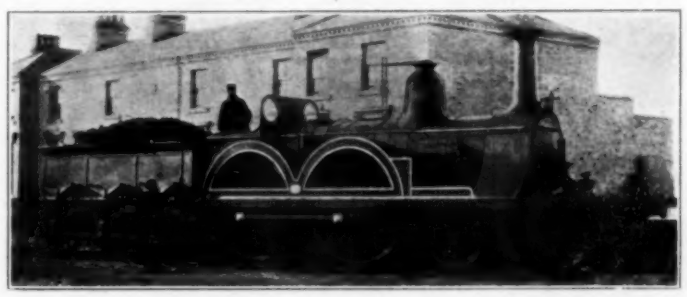


FIG. 155—STEPHENSON'S ENGINE FOR THE S. AND D. RAILWAY, 1862

1886, with 7ft. 6in. driving wheels, had a 19ft. 1in. wheel base and a boiler centre 7ft. 6in. above rails. No one criticised these later engines on the grounds of instability. The criticisms of McConnell's complicated boiler were more to the point, but the truth is that much of the hostility to his engines emanated from Crewe. Old L. and N.W.R. main-line drivers, who had driven both types of engine,[3] told the writer weaker sandwich frame with bolted tie bars, illustrated in Fig. 111 *ante*. The latter lasted about fifteen to eighteen years, whereas the engine illustrated was in regular service until 1904. The last Midland 2–2–2 engine was built in March, 1866.

2–4–0 *Express Engines.*—Three different types, with 6ft. 6in. coupled wheels, may be briefly noted. First a standard express engine, by Sharp, Stewart and Co., 1862–4, for the London, Chatham and Dover Railway. This railway, which was of later in 1860, with 16in. by 24in. cylinders and 6ft. coupled wheels. The bogie wheels were 3ft. 6in. diameter. The large and roomy American type of cab was a distinguishing feature of these two engines, which were intended for the Barnard Castle and Tebay line over the exposed Pennine hills.

Nevertheless, in spite of the obvious improvement in providing adequate shelter for the enginemen, the succeeding four engines—Fig. 155—had the then usual form of front weather boards only. These latter engines were also by Stephenson and Co., 1862, and complete

[1] Colburn, page 258.

[2] These include not only the 7ft. 6in. engines mentioned above, but also McConnell's 7ft. "Bloomers."

[3] See also THE ENGINEER, December 24th, 1875, page 441.

drawings were published in Colburn's "Locomotive Engineering." They were remarkable in having coupled wheels of the large diameter of 7ft. 0½in., though the cylinders were only 16in. by 24in. They might fairly be termed express engines, but the S. and D.R. had no express trains for which such large wheels were necessary, and Colburn describes them as simply

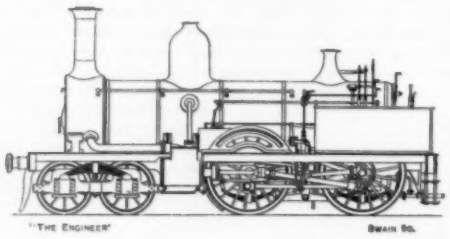


FIG. 156—ENGINE FOR THE L.C. AND D. RAILWAY, 1861-2

"passenger" engines. The bogie wheels were 3ft. 6in. diameter, and to accommodate the horizontal outside cylinders were spaced at 6ft. 1in. centres. The bogie pivot had a spherical upper portion which rested in a socket, through the bottom of which it was prolonged as a stem secured underneath by a nut. This arrangement was similar in principle to D. Gooch's bogie of 1849. There was no lateral movement of the pivot, and very little clearance between the bogie wheel flanges and the main frames, which were not cut away. The coupled wheel centres were only 7ft. 5in. apart. Total wheel base, 20ft. 0½in.; total heating surface, 1053 square feet; grate area, 12¾ square feet; weight in working order, about

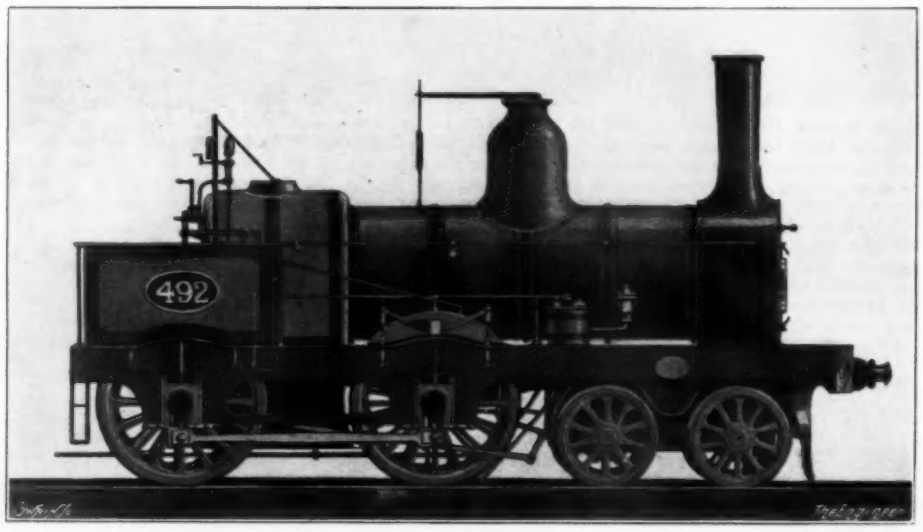


FIG. 157—NORTH-EASTERN LOCOMOTIVE, 1864-5

46 tons. A small auxiliary tank for heating the feed water by means of spare steam from the boiler was placed underneath the footplate.

Twenty-four remarkable 4–4–0 engines—Fig. 156—were built in 1861–2 for the London, Chatham and Dover Railway by the firms of Hawthorn, Slaughter, and the Canada Works (Birkenhead), to the designs of T. R. Crampton. These, with the exception of six 4–4–0 saddle-tank engines previously mentioned, for the same railway, were the only examples in this country of coupled "Cramptons" with rear driving wheels and cylinders placed near the middle of the engine. The Gooch link motion was placed outside. This was the type of engine afterwards so well known on French railways. The cylinders were 16in. by 22in., coupled wheels 5ft. 6in. diameter, with compensating levers between their springs. The valves on the top of the cylinders were inclined at about 1 in 9½. The bogie had outside bearings with 3ft. 6in. wheels and only 4ft. wheel base, and had a radiating movement without side play. The steam from the dome was taken by pipes which came out from the sides of the boiler, so that they were exposed only for part of their length instead of wholly, as in the case of the usual French designs. The heating surface was 1200 square feet, of which the long sloping Cudworth fire-box with longitudinal partition provided 130 square feet. The distance from the bogie pin to the front coupled axle was 9ft. 9in. and the total wheel base 18ft. 11in.

This type of engine was not a success on British railways. The "Chatham" engines damaged the road severely, and it was stated that one or two accidents were due to their having passed over the line immediately before the trains which came to grief. The result was that after about three years' service the engines had to be scrapped. New 2–4–0 engines with inside cylinders and motion and double frames were designed by William Martley, the locomotive superintendent, and constructed by Sharp, Stewart and Co. in 1864, but the boilers of the "Cramptons" were used for them.

The remaining 4–4–0 engines to be mentioned—Fig. 157—were designed by Edward Fletcher for the Whitby-Malton section of the N.E.R. and built in 1864–5 by Stephenson and Co. The Whitby line is noted for extremely severe curves, and the use of a bogie was a practical necessity, when the time came for replacing the four-wheeled engines which had till then worked the line. The cylinders were 16in. by 22in., the driving wheels 5ft., and the bogie wheels 3ft. diameter. As in most inside-cylinder engines of that period, the bogie pin was placed behind the vertical centre line of the smoke-box. These engines worked on the Whitby line for about twenty-five years.

But the 4–4–0 bogie tender engine had not yet gained a solid footing in this country, and the examples described above were exceptional. It was not until the mid' seventies that the bogie for passenger tender engines could be truly said to have come to stay. Only on the Great North of Scotland Railway, where it was introduced by Messrs. Stephenson in 1861, did it become standard practice, and from that date no more 2–4–0 engines were built for this line.

Institution of Mechanical Engineers.

An extra general meeting of the Institution of Mechanical Engineers was held in London last Friday evening for the purpose of receiving and discussing the fourth report of the Steam Nozzles Research Committee. The Committee, it will be recalled, was established in 1914, just before the outbreak of war, but its first report was not published until 1923. Captain H. R. Sankey is its chairman and Professor G. G. Stoney its reporter. The research work has been and is being conducted at Manchester, under the superintendence of Mr. Telford Petrie.

The fourth report is a somewhat lengthy document, composed largely of a series of tables. It was presented last Friday by Professor Stoney. Below we give a summary of it sufficiently full to make its general trend understandable.

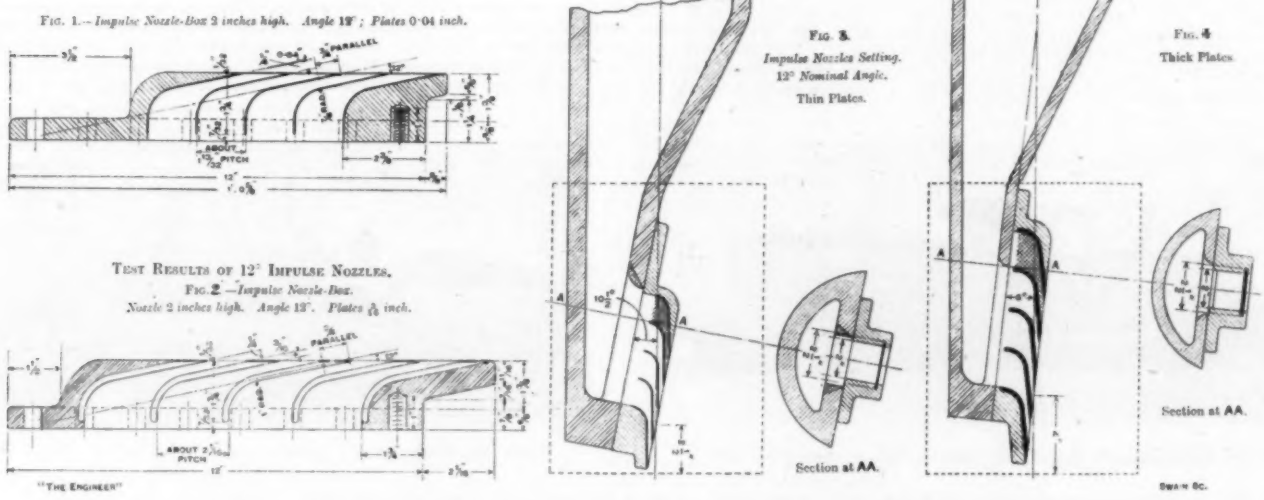
Steam Nozzles Research.

The original programme of the Committee covered tests on (*a*) standard Parsons 1in. nozzles; (*b*) 20 deg. convergent impulse nozzles with thin and with thick blades; and (*c*) 12 deg. convergent impulse nozzles, also with thin and with thick blades. Sections (*a*) and (*b*) were covered in the Committee's first, second and third report. The fourth report deals with the 12 deg. convergent impulse nozzle tests, and with additional investigations.

It may be recalled that the Committee's genera' method of testing the nozzles involves the determination of (1) the average actual velocity of the steam at or near the nozzle exit, and (2) the theoretical velocity at the same point. The actual velocity is determined by measuring the impulse of the jet against a pressure plate and the mass of steam discharged per second. These two factors yield the actual velocity from the formula $C\,m = F\,g/m$. The theoretical velocity is arrived at by equating the kinetic energy of the jet to the mechanical equivalent of the adiabatic heat drop through the nozzle in accordance with the formula $C = 300 \cdot 2\sqrt{d\,H}$. The heat drop is calculated from Professor Callendar's formula for the total heat of steam, for which purpose a knowledge of the pressures and temperatures on the two sides of the nozzle is required. Actually, the two pressures and the initial temperature are observed, the exit temperature being calculated from these three factors, in accordance with the fundamental adiabatic relation, $T \propto P^{n}$. The velocity coefficient of the nozzle is taken as being given by the ratio of the actual to the theoretical velocity $C\,m/C$, and its efficiency as the square of this ratio.

An illustration and description of the nozzle tester, the device employed to measure the impulse of the jet for the purpose of arriving at the actual velocity, will be found in our issue of March 23rd, 1923.

The 12 deg. thin and thick plate impulse nozzles



FIGS. 1 TO 4—THIN AND THICK PLATE NOZZLES, AND SETTING OF NOZZLE-BOXES IN THE TESTER

dealt with in the fourth report are illustrated herewith in Figs. 1 and 2. The setting of the boxes in the tester is represented in Figs. 3 and 4.

Impulse Nozzle 12 deg. Thin Plate.—When the 12 deg. thin plate nozzle was tested, the throat-to-opening ratio being 3 to 1, it was found that the velocity coefficient curve did not show the customary rise at low velocities. To improve the conditions of entry, the small portion of the nozzle pipe shown cross-hatched in Fig. 3, was removed, but a fresh group of tests showed little or no alteration in the form of the curve. Both sets of results, the second lettered N, are represented in curve 17, Fig. 5. As previously the shaded area indicates the estimated limits of accuracy of the test figures. The curve, it will be seen, is practically flat, the coefficient throughout lying between 90 and 91 per cent. The throat-to-opening ratio was then reduced to 2.6 to 1.* The results obtained—curve 18, Fig. 5—again showed no rise in the coefficient at low velocities, although there was an improvement of about 1 per cent. in the mean value. With the ratio farther reduced to 1.6 to 1, two series of tests were made, one at higher and one at lower superheat. The results are shown in curves 19 and 19A, Fig. 5. It will be observed that there is again a general gain of about 1 per cent. in the velocity coefficient, and that with the lower superheat the coefficient begins to show the customary rise at low velocities. With a 0 to 1 throat-to-opening ratio and the higher superheat, two series of tests were made, but difficulty was experienced in obtaining consistent results on account of the existence of unstable conditions in the jet. The results are shown in curve 20, Fig. 5. Some of the points, it will be seen, fall outside the estimated limits of accuracy, and there is little general improvement in the coefficients as compared with those obtained from the 1.6 to 1 nozzle using the higher superheat.

Impulse Nozzle, 12 deg., Thick Plate.—With a 3 to 1 throat-to-opening ratio, the 12 deg. thick plate nozzle gave the results indicated in curve 21, Fig. 6. The results are described in the report as the lowest yet recorded by the Committee for any nozzle. Reduction of the ratio to 1 to 1, curve 22, raised the mean velocity coefficient over the practical range of velocities from 89.5 to 93.2 per cent. When the ratio was farther reduced to 0 to 1, curve 23, the results, unlike those of the corresponding tests on the thin plate nozzle, gave a steady curve, all the points falling within the estimated limits of accuracy. A farther slight increase in the average coefficient is also to be noted. The 3 to 1 and the 0 to 1 thick plate nozzles were also tested with the back edges of the thick partition plates chamfered to a 12in. radius. With the 3 to 1 nozzle, the chamfering raised the coefficient at medium velocities from 89.4 to 92.8 per cent. A very similar figure was recorded in a previous report for a 20 deg. 3 to 1 impulse nozzle, with thin plates. The 0 to 1 12 deg. nozzle, with chamfered edges, also showed improved coefficients at medium velocities, and reproduced fairly accurately the values obtained from a 20 deg. 0 to 1 thin plate nozzle.

Built-up Impulse Nozzle.—Following the discussion on the third report, Mr. B. Pochobradsky supplied the Committee with a nozzle box, in which the nozzles were formed of built-in partitions machined all over. In the Committee's nozzle boxes the partitions were cast in and left in the rough state, usual in commercial practice. The mean efficiency obtained with the Pochobradsky nozzle was about 1 per cent. higher than the best recorded for any of the Committee's nozzles. At the lower velocities the steam conditions were quite steady, but beyond 1000ft. per second the jet became increasingly unsteady, and the pressure readings as a consequence could not be fully relied upon.

Straight Elementary Nozzles.—In the third report—see THE ENGINEER for May 23rd, 1924—the results were given of some tests on an elementary form of nozzle designed by Professor Mellanby, consisting of a concentric group of seven circular orifices, each $\frac{1}{8}$in. in diameter and $1\frac{1}{2}$in. long. The Committee decided to extend this portion of the investigation by testing three elementary nozzles, each consisting of a single orifice, $1\frac{1}{2}$in. in length, and $1\frac{1}{4}$in., $1\frac{1}{2}$in. and $1\frac{7}{8}$in. in diameter. The nozzles and the manner of their attachment to the end of the nozzle pipe are shown in Fig. 8. The results obtained are indicated in Fig. 7. Above 700ft. per second the mean velocity coefficient increases slightly as the diameter of the nozzle is diminished, while all are above the values registered for the seven-orifice nozzle of the third report. By cross-plotting the results represented in Fig. 7, data can be obtained, which indicate the shape to be expected with constant discharge conditions through single elementary nozzles. The curve so obtained possesses most of the characteristics discovered by the Committee, somewhat exaggerated, however. It exhibits the customary gradual diminution of the velocity coefficient from the critical theoretical velocity down to about 700ft. per second, the much more rapid increase from 700ft. to 400ft. per second and the turning over at very low velocities. With the $1\frac{1}{2}$in. elementary nozzle tests were made to determine the effect, if any, of varying the distance between the exit face of the nozzle and the top surface of the pressure plate in the tester. It was found that no appreciable difference was shown with the distance anything between $6\frac{1}{2}$in. and $1\frac{1}{2}$in.

Efflux Angles of the Steam.—After the thin and thick plate nozzles had been cut down to the 0 to 1 throat ratio and tested for velocity coefficient, they were subjected to efflux tests to determine the angle at which the steam jet left the nozzle and impinged on the pressure plate. It was found that the efflux angles in both cases remained practically constant for all velocities below the critical pressure ratio, the value being $11\frac{1}{2}$ deg. to a degree of accuracy of $\pm \frac{1}{2}$ deg., as compared with the nominal angle of 12 deg. The thick plate nozzle with chamfered edges was tested for efflux angle for both the 3 to 1 and the 0 to 1 throat ratio, and was found to have angles of 5 deg. to 7 deg. and 6 deg. to 8 deg. respectively for pressure ratios between 0.9 and 0.55.

The Effect of Superheat.—The degree of superheat in the steam used for the tests is not under the control of the experimenters. During the summer months steam is received from the Bloom-street power station of the Manchester Corporation, the superheat ranging from 30 deg. Cent. at low velocities to 60 deg. Cent. at high. In the winter months steam from the Dickinson-street station, with a superheat ranging similarly from 70 deg. to 95 deg., is available. Two types of nozzle have now been tested under summer and winter conditions, so that it is possible to make a first determination of the correction to be applied to the curves obtained in order to reduce them to some common superheat basis. It would appear that the effect of the higher superheat is to lower the value of the velocity coefficient, and at the same time to move the curve bodily to the left. These effects were shown in the curves for the seven group elementary nozzles dealt with in the third report, and are also exhibited in the curves 19 and 19A—Fig. 5 herewith—for the 12 deg. thin plate impulse nozzle. It is deduced that the correction to be applied to the velocity coefficient of the 12 deg. nozzle ranges from 0.4 per 10 deg. of superheat at a velocity of 400ft. per second to zero at 1800ft., while for the straight

FIG. 5.

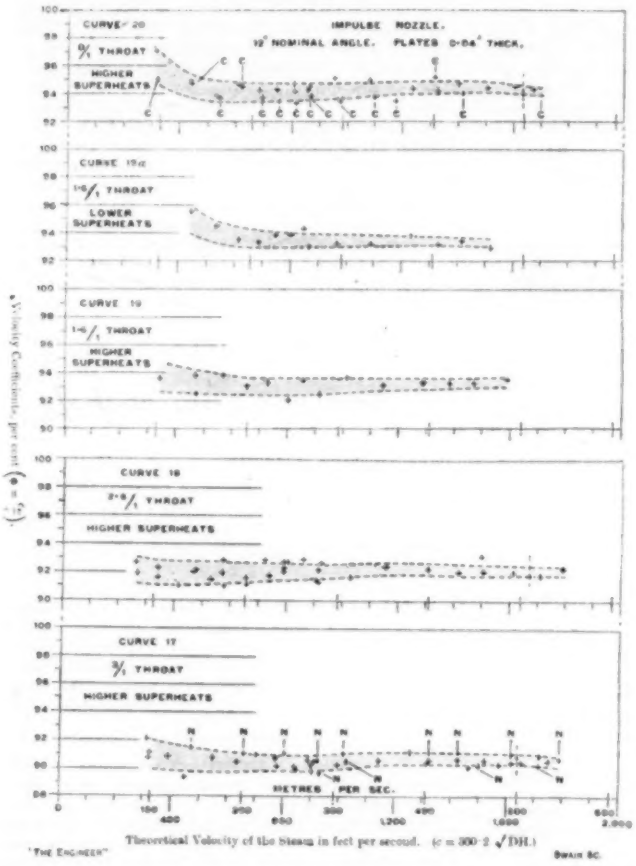


FIG. 6.

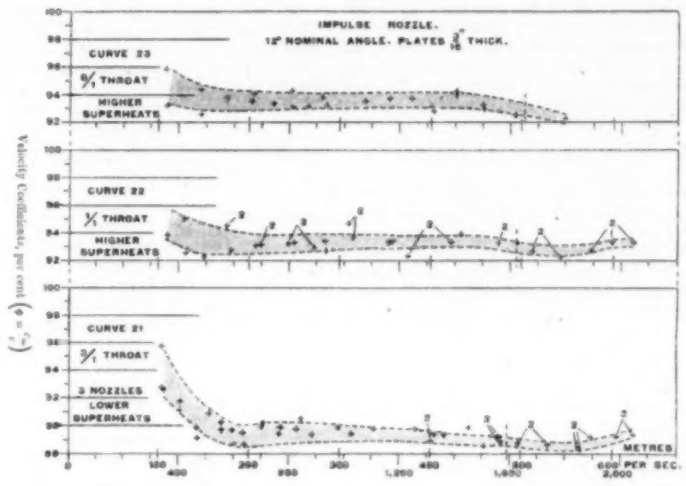


FIG. 7.

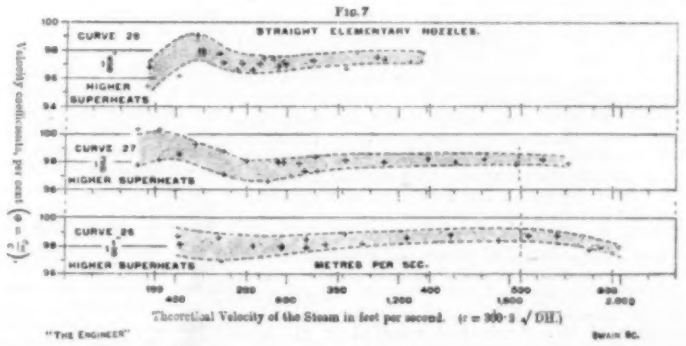
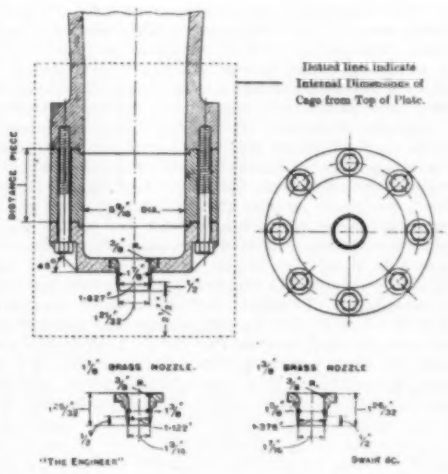


FIG. 8.—*Details of Three Interchangeable Straight Elementary Nozzles.*



* It is explained in the report that the ratio intended was 2 to 1, but that a mistake, not detected for some time, was made in cutting down the nozzle length. Similarly the 1.6 to 1 ratio was meant to be 1 to 1.

elementary nozzles the correction varies progressively from 0.35 at a velocity of 600ft. to 0.10 at 1800ft.

The report concludes with a brief general review of the Committee's work to date. The investigations taken as a whole, it is remarked, show that a wide variation is permissible in the design of convergent impulse nozzles when maximum efficiency is the chief consideration. Thick partition plates can give as good efficiencies as thin plates, if they are carefully chamfered at the exit edges. Below a throat-to-opening ratio of 2 to 1, the length of throat used has little effect in a nozzle of 20 deg. angle, but if the angle is less than 20 deg. throats longer than 1 to 1 should be avoided. Between throats of 1 to 1 and 0 to 1 the nozzle angle may vary between 20 deg. and 12 deg. without any appreciable loss of efficiency. The conditions, both of entry and exit, are important. The steam should enter the nozzle passages with the least possible amount of shock. Flat surfaces in the exit plane of the nozzle should be avoided.

Concluding his summary of the report, Professor Stoney stated that preparations were being made to test nozzles over a different pressure range, with back pressures up to 60 lb. gauge. It was also proposed to test some straight elementary nozzles of rectangular and square section. The Metropolitan-Vickers Company, he added, had tested the seven-hole elementary nozzle and the 20 deg. 0 to 1 thick plate chamfered nozzle. The results obtained with the elementary nozzle agreed with those arrived at by the Committee. Agreement was also found as regarded the 20 deg. impulse nozzle at low velocities, but at high velocities the company's results were 1 per cent. better than the Committee's. The cage and exhaust receiver used by the company were larger than those of the Committee, and steps were being taken to check the effect indicated of the size of those parts.

Mr. H. M. Martin, called upon to open the discussion, said that when he joined the Committee he was not sanguine that it would be possible to do more than confirm the results obtained by previous workers. It seemed very unlikely that any points of real importance could have escaped observation in the course of the almost innumerable nozzle researches previously carried out, particularly in Germany. The unlikely had, however, come true, and the Committee could claim to have thrown quite new light on some nozzle phenomena. The research, for example, had established the fact that the efficiency of a nozzle did not, as some German observers had concluded, diminish continuously from a maximum at or about the velocity of sound, but rose to a second and higher maximum at very low velocities of efflux. He had suggested an explanation of this phenomenon in the discussion on the second report. Again, the persistence of Mr. Petrie had resulted in the discovery of the "flapping effect" of the jet. The effect seriously influenced the efficiency of nozzles with thick parallel plates. From the standpoint of hydraulics, he had always felt that such nozzles were bad, and that the Parsons type of blade must be a better form. The Committee had now shown that with parallel division plates a partial vacuum formed over the wide "lands" at the discharge edge of the blading, with a consequent decrease in the efficiency. He was glad to learn the results of the distance effect experiment conducted with the elementary nozzle. If a simple flat plate were used to take the impulse of a steam jet, the force observed varied with the distance between the nozzle and the plate. It was found, however, that if the plate were faced with a thick porous pad, so as to eliminate the velocity from the steam before it cleared the surrounding cage, the distance effect was overcome. The porous pad used in the Committee's Manchester experiments differed in size from that used at Rugby, on which the original investigation of the effect was made, and it was therefore desirable to confirm the absence of the effect, as had now been done. He was inclined to think that they had not taken full advantage of the possibilities of the impulse method of testing, and that it would have been useful to have made the nozzle box larger than that adopted. So far as he was aware, it had not been possible in any other apparatus to cover a range of velocities as wide as that investigated by the Committee. It should be remembered, however, that the impulse type of tester was not suitable for tests involving speeds exceeding that of sound in the jets from convergent nozzles. The figures obtained in such conditions could not be regarded as exact. The tester was not designed for such speeds, but for those encountered in ordinary practice.

Mr. B. Pochobradsky remarked that the nozzle tests conducted by the Committee were not only of scientific importance, but certain of the results arrived at had already been embodied in turbines of a new type, some of which were already running. The fourth report confirmed the conclusions arrived at in its forerunners, a fact of importance, as showing the great trustworthiness of the Committee's work. He noted that the Committee had come to the conclusion that while the efficiency of the built-up type of nozzle was higher than that of any other form tested, the probable accuracy of the results was stated to be less than usual. The instability of the flow noted with the built-up nozzle was, he believed produced by (*a*) the fact that the division pieces did not have sharp edges on the inlet side, and (*b*) that each of the three steam passages in the nozzle block was of a different form. Possibly, too, the instability might be assisted by the fact that the finish of the nozzle surfaces was good, with the result that the steam on the convex sides of the passages would flow at a higher velocity than it would reach in an unmachined nozzle. The results given by the Committee for the built-up nozzle were not corrected for the effect of superheat. Making that correction on the lines indicated in the report, he found that the superior efficiency of the built-up nozzle relatively to the unmachined form was enhanced. At 400ft. per second the velocity coefficient after correction became 98.5 per cent., and at 1800ft. per second 96.4 per cent. The superiority of the built-up nozzle at the higher velocity was thus increased to 2 per cent. as regarded the velocity coefficient, and 4 per cent. as regarded the efficiency. The reason for the enhanced efficiency of the built-up nozzle was, doubtless, the fact that it was machined to a smooth surface all over; but that fact could not explain everything, for the Parsons form of blading was also made with a smooth surface. Additional reasons were probably to be found in the circumstances that the steam had an easy flow through the built-up nozzle by reason of the large radius used, and that the area from the inlet to the throat varied in a gentle manner. With the higher pressures to be tested, he thought that the finish given to the blading would play a very important part in determining the performance of the nozzles.

Mr. J. E. Shakeshaft expressed surprise at the nature of the superheat effect found by the Committee, and suggested that additional research on that effect might with advantage be undertaken in view of the wide range of temperatures within which steam was now used in turbines. Turning to the effect on the impulse recorded of the distance between the nozzle and the plate, he criticised the Committee's conclusion that the effect was inappreciable with the distance anything between 6½in. and 1½in. In the three curves reproduced in the report to illustrate the alleged absence of the effect, all the points except one lay *above* the mean curve when the distance was 6½in.; they were fairly divided above and below the mean for 4½in.; and all except two lay *below* the mean for 1½in. It might be true that the departures from the mean were in all cases within the band of estimated experimental accuracy, but he held that it was permissible to draw from the curves a conclusion the opposite of the Committee's, namely, that the distance effect was appreciable. Concluding, he asked whether any discharge coefficients had been worked out for the Committee's latest results, and, if so, whether, as previously, minimum values had been discovered at speeds round about 800ft. per second.

Mr. Telford Petrie remarked that all the points plotted for Mr. Pochobradsky's nozzle were well within the wide band of accuracy estimated for the results. The figures were probably being obtained with as great accuracy as in the case of the other nozzle forms, but in view of the fluctuation of the pressure-measuring mercury column, it would not have been fair to claim the same accuracy for the tests as could be claimed for others in which there was no such fluctuation. He agreed with Mr. Pochobradsky's remarks regarding the effect of superheat on the results obtained with his nozzle, and accepted the figures as corrected. Mr. Shakeshaft was quite correct regarding the distance effect curves. One could read into them the conclusion suggested, but it was also possible to console oneself with the reflection that any effect observable was within the limits of experimental error. The discharge coefficients had been worked out, and would be published in due course, but except perhaps in one case, the minimum previously noted had not again been observed. Between 800ft. and 1000ft. per second, the discharge tended to become unstable. Reviewing the Committee's results as a whole, he said that to his mind the most impressive fact discovered was that the upward bend in the curves at low velocities began earlier with low throat lengths than with high. It would seem that some disturbance must be taking place inside the nozzle. This disturbance, he suggested, depended upon the conditions of entry. It was impossible to design a nozzle to give perfect entry at all velocities. Provided the disturbance was well inside the nozzle, full-bore discharge and good working were secured, but as the throat length was cut down the effect moved back.

Mr. L. Pendred said that he was struck by the apparently very bad shape of the entry to the nozzles, and asked whether that shape had been adopted to suit the experiments or to accord with practice. The form of entry shown in Figs. 3 and 4 seemed to provide a very inconvenient path for the steam. Not only had the steam flow to turn round sharply into the nozzle passages, but one part of it had to pass behind another in order to reach a lower nozzle. He suggested that the conditions might be improved by the insertion, on the inlet side, of guide blades curved in the reversed direction to the nozzle passages.

Professor Stoney, replying to the discussion, said that the turbine designer was constantly faced with the problem of keeping the length of the blades as low as possible, in order to reduce the overall length of the turbine and to avoid critical velocity troubles. That fact influenced the design of the tester, but he agreed that it would have been better if more freedom had been allowed in the nozzle pipe. In addition to keeping the length of the blades low, the designer in the case of a large turbine had to face the difficulty of making the partition plates strong enough to withstand the steam pressures used. Thick plates for that reason were desirable, but their low efficiency rendered them unsuitable. The importance of the effect of chamfering the exit edges of thick plates discovered by the Committee was therefore great. As regarded the effect of superheating the Committee, as stated in the report, had no control over the degree of superheat in the steam, with which the experiments were conducted, but the question of fitting a gas-fired superheater to the test plant was now being considered. Concluding, he remarked that it had always to be remembered that, in the Committee's experiments, the pressure plate was in the standard arrangement, 2½in. away from the nozzle exit. In an impulse turbine the corresponding dimension would be about ¼in. For that reason the test results might not be directly applicable to actual steam turbines. It would, no doubt, have been better, theoretically at any rate, to have used an impulse wheel instead of the nozzle box and tester, but the expense of changing the blades of such a wheel would have been too great, and, in addition, the quantity of steam consumed would have been excessive.

Iron and Steel Institute.

No. I.

THE annual meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers on May 7th and 8th, under the presidency of Sir Frederick Mills, who took office in succession to Sir William Ellis, who has been elected as the next President of the Institution of Civil Engineers.

Sir William Ellis, in acknowledging a vote of thanks on his retirement from the chair of the Iron and Steel Institute, expressed the hope that his election as President of the premier engineering institution might not be without its influence in emphasising the need of a closer alliance between the engineer and the iron and steel industry.

BESSEMER MEDAL.

Sir Frederick Mills, in presenting the Bessemer Medal to Professor Thomas Turner, said that the name of the recipient had been familiar to them for many years as Professor of Metallurgy at Birmingham University, and as the head of a department which had become famous for its metallurgical researches and prolific in publications dealing with many branches of ferrous and non-ferrous metallurgy. He would remind them of Professor Turner's early researches on the influence of silicon on the properties of cast iron, the results of which met with immediate and wide application. His studies of the effect of each of the elements present in cast iron might be said to have laid the foundation of scientific ironfounding. His other work included studies on the formation and varieties of graphite in cast iron, on the microstructure of castings, on the changes in volume during solidification, on the influence of the rate of cooling and of casting temperatures, and the nature and properties of metals other than iron and steel, and the invention and design of a sclerometer for the purpose of testing the hardness of metals. Professor Turner had been President of the Staffordshire Iron and Steel Institute and was at the present time President of the Institute of Metals. He was an honorary member of a number of metallurgical societies in the Dominions and in foreign countries. His own University lately manifested its appreciation of him by the establishment of a trust for the award of Thomas Turner Gold and Bronze Medals, and prizes for metallurgy in the University of Birmingham.

Professor Turner, in acknowledging the award, referred to the fact that when he read his first paper before the Iron and Steel Institute, Sir Henry Bessemer was President, and he had still fresh in mind the kindly congratulations of that great metallurgist.

The President then delivered his inaugural address, of which a report appeared in last week's issue.

Sir Frederick Mills said that since he wrote the address he had paid a visit to the Hagfos works of the Uddeholms Aktiebolag, in Sweden, where he saw mild steel made in an electric arc furnace direct from iron ore. The ore used was concentrate, containing 65–70 per cent. of iron, and was mixed with 22 per cent. of fine coal and 10 per cent. of lime; 2500 kilowatt-hours per ton were required for the whole process of reduction and refining. The resulting steel was quite fluid and of good quality, and he had brought with him a sample of the briquette and the steel. The process was admittedly in its experimental stage. The question of speed and of economy remained to be demonstrated, but the company had dismantled one of its modern electric smelting furnaces, and had decided to install in its place a new unit to test the process. If the figures of cost, both capital and manufacturing, given to him were confirmed by results, a revolution in steel making,

which must have far-reaching effects, was in the making. Could we picture a steel-making centre where the low-temperature carbonisation of coal would provide gas for gas-electric engines, smokeless fuel for manufacturing and household purposes, and electricity for making steel direct, without the intervention of blast-furnaces and pig iron and without smoke ?

The Council's annual report says :—

During the past year ninety-nine new members and sixteen associates were elected, and nine associates were transferred to membership; the total membership of the Institute on the register on December 31st, 1924, was therefore as follows :—Patron, 1 ; honorary members, 11 ; life members, 80 ; ordinary members, 1964 ; associates, 37 ; total, 2093. Seventy members and one associate resigned their membership during the year, and the names of forty-three members and five associates were removed from the register owing to the non-payment of subscriptions.

The income for the year under review was £8068, exclusive of the Carnegie Scholarship Fund and of the interest received from investments constituting the Special Purposes Fund, and the expenditure for the year was £7568.

Grants were made during the year by the Council, on the recommendation of the Carnegie Scholarship Committee, to the following candidates :—

C. H. Adamson (Sheffield) and G. S. Bell (Lincoln), £100 jointly, to carry out an investigation on transverse test bars of cast iron of various mixtures, and to determine the relation between the strength, properties and chemical composition.

L. Aitchison (Birmingham), £100, to carry out a research on the critical quenching velocity of steel and the influence of composition upon it.

C. E. Pearson (Newcastle-on-Tyne), £75, to investigate the growth of commercial grey cast iron, with special reference to composition, grain size, and casting thickness.

E. R. Taylor (Birmingham), £75, to ascertain the relationship between sulphur and other ingredients of white iron in connection with the production of white-heart malleable castings.

It was also recommended that a further grant of £50 be made to O. W. Ellis (Toronto University), who had received a grant of £100 in 1922, to enable him to install certain apparatus for continuing his research work already reported on.

A paper by Mr. T. W. Hand on "Progress in British Rolling Mill Practice" was first on the agenda. An abstract of it is given below.

PROGRESS IN BRITISH ROLLING MILL PRACTICE.

Some twenty-four years ago Mr. William Garrott, in reading a paper before this Institute, endeavoured to show, from an American viewpoint, where and to what extent British rolling mill practice fell short of requirements essential to industrial success.

Admittedly ideal conditions can scarcely be realised in certain steel works of this country where plant installed by early pioneers has been limited in development through site conditions or financial disability, and remodelling has consequently been permanently handicapped. Further, some temporary advantage as regards low overhead charges can at times be claimed for continuing to work an old plant, which has, in course of time, been written down to a merely nominal capital value. Making due allowance for these important considerations, however, one feels forced to the conclusion that Mr. Garrett's criticisms, whilst perhaps severe, were in the main justified, as no serious attempt appears to have been made during the next fifteen years to keep pace with the class of mill machinery then being installed by rival nations.

It is difficult to find any adequate explanation of this policy, as obviously keen competition can only be met by improved methods, and possibly more complete recognition of the limitations of human endurance and will might have resulted in fuller development of mechanical means, and created thereby a higher standard of output. This latter is the all-important factor, and if the reasoning now generally accepted in America be admitted, that the investment cost per unit of annual production is approximately equal for all classes of mill machinery, it follows that the largest producing plant is the better investment, as the necessary replacement of arduous manual effort by mechanical devices results in indisputably lower operating cost.

The author then describes many American mills and contrasts British with American practice. With regard to British plate mills he says :—

Whilst there are still many obsolete British plate mills, it can with perfect justification be claimed that the new plants laid down in recent years embody all the best features of modern practice. Manual effort has, in fact, been perhaps more completely eliminated in certain of these mills than in any similar foreign plant. This claim applies in particular to the shearing of plates, formerly a most arduous operation, but now entirely mechanical for all other than irregularly shaped or sketch plates. Very naturally, in an individualistic country, differences of opinion exist, and various methods of shearing are in use, each of which has proved advantageous for particular conditions, and to which reference is made later.

He illustrates the Clydebridge Steel Works of David Colville and Sons, Ltd., for a full description of which see THE ENGINEER of August 31st and September 7th, 1923. Of it he remarks that the breadth of vision rightly credited to mill owners in America has not been lacking in developing the installation. The plant incorporates many novel features, and is probably one of the most efficiently manned mills in existence, practically every known mechanical device for easing manual effort being incorporated. The mill is the first of its type in this country to be operated by a direct connected reversing type mill motor, the primary object of this being to retain the advantages incidental to speed adjustment obtaining on reversing mills. This motor can take peak loads up to 13,000 horse-power.

In the author's opinion the class of plate mill which has received least consideration in this country is that devoted to production of the smaller rolled products, many works otherwise well equipped being quite unable economically to convert any considerable portion of their output into relatively small sizes.

Admittedly considerable improvement has been made in the mechanical details of mill trains, methods of driving, &c., with some resultant increase of output, but the fundamental factors associated with feeding of hand-worked mills and difficulties in dealing with long rolled lengths in their hot state impose a very definite limit of production on this class of mill.

The old belief that anything capable of turning round was good enough for rolling mill work is fast disappearing, and scientifically designed machinery is now well established in the leading steel works of most countries. Such design necessarily embraces the vital considerations of selection of materials of construction, accurate machining of working surfaces, and possibly more important still, adequate lubrication, with total enclosure wherever possible of lubricated surfaces. These provisions are necessarily reflected on the running of the mill, it now being quite possible to run a complete cogging mill train and its electrical equipment with a power consumption of about 220 kilowatts at light load, probably at least two-thirds of such power being absorbed by the fly-wheel converter set. The advantages resulting from complete electrification of main and auxiliary drives have been so fully discussed that further comment would appear to be superfluous.

Such developments as have been described, whilst gratifying to many are disturbing to others, who appear to be under the impression that for some inexplicable reason highly specialised plant is not well adapted to our moderate and varied output. The author would submit, however, that with a population which, in spite of the ravages of a great war, is estimated to have increased by 2,000,000 since 1914, an ever-increasing production must be maintained if such numbers are to be supported. This can only be achieved by unremitting attention to costs of production—a consideration to which the iron and steel producers of America, even with their great natural advantages, are now giving first place.

In this connection it has occurred to the author in reveiwing the foregoing pages that as the best of British plants only have been referred to, a stronger feeling of security than is intended may be conveyed.

In view of this it appears necessary to emphasise that the plants referred to cover practically the whole field of modern development in this country, and as such cannot be considered excessively disproportionate to our needs.

From the necessarily privileged position of business association with many of the schemes projected by competing nations, it can be definitely stated that unless a more ruthless policy is practised in the scrapping of obsolete plant than has hitherto obtained it can scarcely be hoped to produce at the cost necessary to ensure sale of the bulk of the home product in the open markets of the world. Admittedly, the present is not the most opportune time for preaching the gospel of expansion, but if the analysis attempted in this paper results in full and useful discussion of what is undoubtedly a vital branch of the British iron and steel industry, its purpose will be well served.

Opening the discussion, Mr. Frank Anslow said that the list of plants given by the author was not quite complete. It did not include that of the Scottish Iron and Steel Company, which had installed a steel works with modern rolling mill plant and handling plant. The whole of this plant was operated by electric power, produced by means of mixed-pressure turbines, supplied with exhaust and surplus steam from the adjacent ironworks. The author made a strong point of mechanical handling, which he (Mr. Anslow) agreed had not received adequate attention. Broadly speaking, the big works in Great Britain producing steel billets and heavier sections were being developed on sound lines and following American practice in regard to output and arrangement for cheap production. The position of the works operating three-high continuous mills in the 9in. to 12in. class, producing merchant sections, was not so good, and the mills were not so favourably situated as corresponding American and continental mills. Even those mills in Great Britain designed to produce a large output of merchant sections, which when fully employed could be operated at low costs, could not produce economically on a low output. There were other mills producing a great variety of sections on a small scale, which could be profitably employed under certain conditions, but lacked the capacity to produce the output required when trade was good. The problem was to design a mill and lay-out between the two extremes, capable of giving a reasonably large output under all conditions and of doing it economically. The question of power consumption had been dealt with by the author of the paper, but the figures quoted were high, and in a number of cases of which he had knowledge the production was about 33 per cent. higher and the power consumption at least 30 per cent. below the figures quoted in the paper. The relation between cost of power and output could be shown on a curve, and there was a point at which the costs became fixed, while output increased. That point had to be determined for different plants.

Captain L. D. Whitehead referred to what was being done at the Tredegar Works to obtain increased output by means of improved heating arrangements and reducing the size of the billet. Experience of continuous mills at Tredegar extended over about nineteen years, and it had been found possible even under the depressed trading conditions of the past three years to run at 96 per cent. of full capacity. It was essential with a continuous rolling plant to have the mill on the right site, as the continuous mill could not be operated to advantage on inland trade. There were two requirements of an iron and steel plant to which attention must be given ; ample stocking facilities and adequate railway transport must be available. He believed there was a great opening in English trade for a continuous mill plant. An 18in. billet mill as an adjunct to the finishing mill was a great asset. He would emphasise the fact that it was unnecessary to start with a large billet.

Mr. Lambert Rothera referred to the author's account of the Illinois equipment, and said that the same thing was being done at Clydebridge Works. The capital cost of such an installation was high, but was more than compensated for by the advantages in operation. In that plant it was found that by using the mill reversing for the early passes, the output was improved and the power consumption diminished.

Mr. H. B. Toy commented on the fact that the best iron and steel works equipment in Great Britain had been either designed or built abroad, and it would appear that British manufacturers of iron and steel-making machinery had neglected their opportunities. The universal mill was a wonderful machine, but its operation introduced difficulties in keeping the plate perfectly straight. Speed of operation was all-important, and in many British works the power necessary for speedy production was lacking. Important economies could be realised by giving more attention to that point.

Sir William Ellis said that there was room for a good deal of work in modernising the equipment of home steel plants, but many of those responsible for works operation took shelter behind the excuse of bad trade and the tightness of money. He would urge upon those who hesitated to incur outlay in modernising their equipment, owing to the low prices which the product realised, that in these circumstances it was more than ever necessary to face expenditure that would cheapen costs of production. Reforms which did not involve very large capital cost would be fully justified.

Mr. Hand, in replying to the discussion, pointed out that a 44in. American mill was comparable to a 40in. British mill. He had knowledge of what was being done in other countries, and had learned that in Belgium one of the finest combination mills which could be designed had just been installed. If continental nations could do that and follow the example of United States manufacturers, it seemed strange that it was not being done in Great Britain, the original home of the iron and steel industry.

Mr. A. Hultgren then presented a paper on "Flakes or Hair Cracks in Chromium Steel, with a Discussion on Shattered Zones and Transverse Fissures in Rails." the contents of which are summarised below :—

"FLAKES" OR "HAIR-CRACKS" IN CHROMIUM STEEL.

Internal cracks, previously denominated "snow-flakes," "flakes," or "hair-cracks," and found principally in certain alloy steels, have appeared in large-sized bars and forgings of high-carbon chromium steel for ball and roller bearings. The formation of flakes has been studied by rolling and forging experiments, carried out under varied conditions.

It has been found that such flakes when present invariably formed during cooling after the final hot working operation, and that their formation is prevented by retarded cooling. The defect may therefore be designated as cooling cracks.

Suggestions are given as to the proper method of retarding the cooling to prevent the formation of flakes, at the same time avoiding the undesirable effects of slow cooling on the structure and on the physical properties of the steel.

The mechanism of the formation of flakes as a consequence of cooling stresses is discussed, and the influence of large dimensions emphasised.

The significance of other factors, such as amount of inclusions and composition of the steel, as contributory causes of flakes, is discussed.

It is believed that the reheating and the hot working practice are of minor consequence in this respect.

So-called "silver streaks" in alloy steels are believed to be flakes that have been elongated in subsequent hot working without welding together.

The so-called shattered zones in rails are believed to contain cooling cracks, formed in cooling after rolling, as suggested by Howard, and consequently are identical with flakes.

The mechanism of the formation of transverse fissures in rails is discussed.

Dr. W. H. Hatfield welcomed the paper as one of great interest to manufacturers of alloy steels. He was glad to say that in British practice the difficulties referred to by the author had been overcome. Almost every operation in the manufacture of steel had been held responsible for the production of "snowflakes," but in the works with which he was associated the trouble had been eliminated by controlling the reactions in the furnaces, the casting temperature, and the speed of teeming in relation to the size of the ingot. There was no room for doubt that any trouble which arose could be traced back to the ingot. Faults in the ingot might not be actual defects, but could develop into defects. Sometimes the condition in the ingot was confined to the existence of planes of internal stress, and not actual separations of surface ; but he was convinced that the seat of trouble was to be looked for in the ingot.

Mr. H. Brearley, while agreeing that defects in the ingot were the primary cause of the defects dealt with in the paper, contended that some influence was exerted by forging operations. During the war period, when it became necessary to employ iron workers on steel production, and the heats customary in ironworks were often employed, the metal contained many examples of "snowflakes."

Mr. E. H. Saniter thought that Mr. Hultgren's evidence proved his contentions that the cracks which developed were cooling fractures in many cases, and had nothing whatever to do with the manufacture of the steel.

Mr. T. H. Turner raised the question how the material was affected by the rate of cooling. The type of fracture which the author had observed was a frequent source of fatigue failure.

Mr. H. H. Ashdown disagreed to some extent with Dr. Hatfield, and agreed with the author. Defects were revealed during the cooling process which did not develop during subsequent heat treatment. The risk of this trouble occurring was considerable, but when the cause had been traced it could be avoided. It was now a somewhat rare occurrence for cracks of the type dealt with in the paper to be met with in practice. In his opinion, the cause was to be traced to non-metallic inclusions, but if great care were exercised in cooling down from forging temperatures the trouble would disappear.

Dr. Thos. Swinden said that he had had a good deal of experience of the kind of defect illustrated in Fig. 9a. The trouble was most pronounced in two types of steel made in the electric furnace, magnet steel containing 6 per cent. of tungsten, and another steel containing 1 per cent. of carbon and 2 per cent.

of magnesium. The defect was attributed to non-metallic inclusions. Assuming that fissures arose after forging, the question of correlating forging methods presented itself, but the subject was complicated by the fact that different forgings required different methods of heating and cooling. At the same time, although the trouble originated after or during forging, the cause went back to the steel-making process. In the electric furnace attention must be given to a reduction of the voltage during melting, particular care must be observed in connection with slag conditions, and a lower speed of casting than was usual should be adopted.

Mr. Hultgren, in concluding the discussion, said that the phenomena dealt with in the paper were more varied in their occurrence than was generally known. His own task had been to solve a definite practical problem, and he had the assurance of manufacturers that he had succeeded. Dr. Hatfield had said he was mistaken as to the cause of "snowflakes," but Dr. Hatfield did not produce any evidence in support of his own theory. There was definite evidence, however, as to the effect of a variation of cooling conditions. The suggestion had been made that the particular defect investigated might exist in a form which escaped detection. That opened up another aspect of the question, but in his experiments the actual cracks were visible in the microscope, and were not mere areas of weakness from which cracks might be developed. Slow cooling had proved to be an effective remedy. If cracks were found in the ingot, they would probably be welded up during one of the stages of hot working, and could not have the same appearance as the cracks he had discovered. The whole subject was complicated, and called for further study.

Two papers, one by Mr. T. H. Turner and Mr. J. D. Jevons, on "The Detection of Strain in Mild Steels," and the other by Mr. Jevons on "Strain Detection in Mild Steel by Special Etching," were presented by Mr. Turner, and were the subject of a joint discussion. Abstracts of them appear below.

THE DETECTION OF STRAIN IN MILD STEELS.

Many of the best-known metallurgists and engineers have applied themselves to the subject of strain in metals, directly or indirectly. Nevertheless, it is still impossible or extremely difficult to detect, by ordinary means, strain in a mild steel, unless the material has been drastically cold worked and is severely strained. Slight permanent strain present in steels deformed but little cannot be recognised under the microscope by the ordinary worker. Few would be able to differentiate microscopically, or indeed by any other means, between two pieces of the same mild steel, the one stressed below and the other just above the elastic limit. Were such differentiation possible, information could be obtained of undoubted value to designers and users who are interested in the behaviour of new constructions, or in the cause of the failure of some steel part.

While employed in an engineering works one of the present authors carried out the usual type of post-mortem investigations necessitated by the failure in service of various types of mechanisms. It was then thought that the location of strained areas in steels would be similar to the stress concentrations indicated by Coker and his collaborators in their work with polarised light, and transparent bodies stressed within their elastic limits. It was felt, however, that it was not safe to go far in applying those results to the common metals and alloys; materials whose structures differed fundamentally from those of such transparent bodies.

Further experiences led to the idea that it might be possible to develop a method of investigation which would enable the metallurgist to detect the presence of strain, the stress direction which produced it, and possibly even its magnitude. Such a method of strain detection is unfortunately still an ideal.

Observations they have made enable the present authors to state that in straining a four-sided specimen of mild steel in tension distortion wedges begin to advance across the section as soon as the yield point is reached.

At first these narrow wedges of distorted material only advance along two planes at right angles to one another. At a later stage, when further straining occurs, the distortion wedges also appear upon two other planes roughly at right angles to one another and at 45 deg. to the first two planes. All four planes, along which the distortion wedges advance, are roughly at 45 deg. to the longitudinal axis of the specimen. Conformity to any constant angle is prohibited by the constant redistribution of stress which any local distortion of the metal structure entails. The distortion wedges are straight sided or curved sided. In cases where the stress has been applied from a curved object, as, for example, in the Brinell test or in drifting out a circular hole, the distortion wedges starting from the source of strain have curved bases and curved sides.

The specimen is reduced in cross section wherever distortion wedges appear after elongation. The microstructure of the metal in such wedges exhibits slip, crystal breakdown, or grain boundary failure when seen under the microscope, after suitable treatment.

Lüders or Hartmann's lines are the surface signs of distortion wedges. Wedge is here used advisedly, for the distortion is neither a surface phenomenon nor mass slip along a plane right through the section.

The first distortion wedge to appear always starts from the most highly strained locality, and advances across the section at the same time as it broadens at the base. Rupture only takes place after the distortion wedges have intersected one another all over the area of the failure.

Abnormal grain growth does not occur where two distortion wedges intersect, but does occur in the area where more than two such wedges intersect.

In the distortion wedges of a flat bar tensile specimen the metal appears to have started a movement towards the central axes. This result, which somewhat resembles the reduction in section of a piece of rubber when it is stretched, is probably due to crystal slip, which takes place in three directions towards two axes of the specimen—that is, one slip direction towards the apex and two other directions parallel to the faces of the wedges, and opposed to one another. For other shapes of specimen distortion, wedges form in keeping with the geometrical arrangement of the stresses.

It is not clearly understood why distorted metal and undistorted metal so often lie side by side, in what almost amount to laminations, or why a second distortion wedge nearly always commences to grow before the first has grown to its full extent.

Small ball hardness tests upon carefully polished specimens have shown conclusively that the distortion wedges are definitely harder than the apparently unstrained metal lying between them. In ordinary commercial hot-rolled bars distortion wedges are produced in greater number, or appear more plainly, when the strain has been produced in the direction of rolling.

The etch patterns produced by the same type of strain applied transversely and longitudinally undoubtedly differ in their characteristic forms.

Specimens strained after they have been quenched from above 900 deg. Cent. do not appear to show signs of the distortion wedges, which are obtained upon the same material strained in the as-rolled or fully annealed condition.

CONCLUSIONS.

The authors have surveyed all the methods which appeared to give any promise of yielding a practical method of detecting strain in steels.

They find that distortion wedges are characteristic of strain in normal carbon steels, but that they are difficult to observe.

The combined tempering and etching process is the most informative process, but has only been applied successfully to mild steels.

The mechanism of the distortion of normal commercial steels has now been explained in a manner more in accordance with the facts observed than was previously possible. The conception of the distortion wedge is, they believe, novel, and will be, they hope, of value. No attempt has as yet been made to correlate the facts observed with the recent work of Millington and Thompson. Any connection between low temperature thermal, magnetic, and fatigue critical arrest points; blue brittleness; the critical low temperature annealing which aids the solution of strained areas in the etching of distortion wedges; and possibly abnormal grain growth, have still to be proved.

Steels may show strain-etch figures after heating so as to destroy any blue brittleness.

The subject of strain detection is of importance to steel users and requires further investigation.

STRAIN DETECTION IN MILD STEEL BY SPECIAL ETCHING.

Part I. of this paper records the results of an investigation by the present author of factors which influence such etching processes, while in Part II. some strain-etch figures obtained by the practical application of such a process are described. The special etching process referred to above is briefly as follows. Specimens prepared as usual for microscopic or macrographic examination—special care being taken to avoid distortion by vigorous grinding or polishing—are given a short low temperature annealing at a "suitable" temperature; half an hour at 200 deg. Cent. being suggested. They are then etched in one of the following solutions until the desired result is obtained, which for macrographic etching is usually in five to twenty minutes.

No. 1 Solution. For Macrographic Etching.

120 cubic centimetres concentrated hydrochloric acid.
100 cubic centimetres water.
90 grammes crystallised copper chloride.

No. 2 Solution. For Microscopic Etching.

40 cubic centimetres concentrated hydrochloric acid.
30 cubic centimetres water.
25 cubic centimetres ethyl alcohol.
5 grammes crystallised copper chloride.

In macrographic etching the specimen is rubbed with a rag moistened with solution and dipped in powdered copper chloride. The specimen is dried without rinsing in water, washed in alcohol and again dried. The etched pattern consists of dark and light bands. These bands appear where a disturbance of the crystals has taken place, and it is possible to distinguish under the microscope whether the difference producing the dark lines is due to disintegration of the crystals, deformation of the crystal boundaries, or slipping of the crystal surfaces. These lines have only been obtained on mild steel, and not on all mild steel with the same distinctness.

It would appear that by subjecting suitably prepared specimens to a preliminary low temperature annealing, followed by a prolonged etching in certain solutions of copper chloride, strain-etch figures may be produced on many, but not all, steels. Beyond the fact that a fairly low carbon content is apparently essential, no connection has yet been traced between the chemical composition of steels and their ability to strain-etch. Provided that permanent deformation has occurred, the actual degree of distortion has but little influence on the quality of the markings.

The figures developed on steel surfaces by the etching process described in Part I. of this paper consist of dark areas and lines composed of permanently deformed metal. By the examination of sections and of the sides of specimens it has been definitely proved that:—

(1) There is an abrupt change in hardness on crossing any line in the figures dividing light and dark areas. Impressions taken with a 1 mm. ball as close as possible on either side of a dividing line show a difference of as much as 50 Brinell hardness numbers, the darker or distorted metal always being the harder.

(2) The etched lines correspond exactly with any Lüders lines produced on the surface of the specimen.

(3) There is an actual reduction in the cross-sectional area of a specimen wherever these bands occur.

(4) The markings produced by etching are really the sides or surface evidence of blocks of permanently deformed metal, which have been named, in the companion paper to this, "distortion wedges."

These wedges are rectangular in section, and although in many specimens they appear as parallel-sided bands, in their incipient stages of development they always appear as slightly tapered wedges. They originate from points of greatest stress, and increase much more rapidly in their length than in their width of base. If the base be straight, as on a rectangular bar, the wedge will grow straight, but if the base be curved, as when the generating point lies on the edge of a round hole, the wedge will be curved.

It may be argued that such strain figures as are shown are of little practical assistance to the engineer and designer, as once permanent deformation has occurred in a piece of metal the system of stresses present therein is at once altered. This, of course, is perfectly true, but for *small* amounts of deformation the stress system will not vary to a marked extent, and the etched figures may be taken as a fair indication of the stresses present in a specimen, and, in any case, the fact that distortion wedges always start from points of greatest stress should in itself prove of value. When considerable distortion has occurred discretion must be exercised in relating resulting figures to original stresses.

It will be seen that this special etching process is capable of yielding highly interesting results, and that its range of application is extensive. In its present form it is subjected to the very considerable disadvantage that strain-etch figures cannot be produced on all steels, and its usefulness in the examination of actual failures is therefore limited, but, even so, it seems probable that at the present time a designer could obtain valuable information by constructing models from steel upon which it is known that satisfactory markings can be produced, straining and etching them. By suitable modifications to the process it may soon be possible to produce markings on all steels, in which event its already considerable value would be greatly enhanced.

Dr. W. Rosenhain complimented the authors on an interesting series of photographs which showed the successful application of Fry's method of etching to previously strained material. That method provided an opportunity of learning the direction of deformation in articles of various shapes. He noted that the lines shown in the photographs were very similar to the optical figures obtained in Coker's method, and the results obtained with amorphous materials did not differ much from those in steel as long as the deformations were not large.

Mr. C. H. Stromeyer, who submitted some samples of defects in metals to the meeting, expressed his desire to discover a test which would show the amount of strain to which a material had been subjected. Fry's method was one way of ascertaining this, but it could not be applied to all steels. He thought that a new line of research which would prove useful was opened up by etching processes. Ordinary etching was based on the principle of adding acids to water, whereas a concentrate solution composed of water added to acids might be used, and mixtures between the two extremes. He had experimented on these lines, but the results obtained had not been very satisfactory. There might be something in the idea of working down from the top end of the scale.

Mr. W. H. Patchell said that his interest was from an angle which had not been mentioned. Users wanted a ready means of testing steel when delivered, and this need had arisen in connection with the use of high boiler pressures. He was responsible for boilers working at 400 lb. and for one unit which was operated at 1200 lb. The drums of the 400 lb. pressure boilers were 2in. thick, and called for the use of rivets 6in. between heads. The 1200 lb. boiler was forged from a steel ingot. It was desirable to be relieved of the need of this heavy type of construction.

Dr. W. H. Hatfield said that the trouble in boilers was in the neighbourhood of the rivet holes, and any process which would indicate the state of the steel in those positions would be very valuable. One interesting feature brought out was that the maximum etching effect appeared to be coincident with the amount of cold work which produced grain growth.

Dr. C. H. Desch referred to unsuccessful attempts made to repeat the author's results, and said that the explanation must be the difference in the character of the steels. He would like to have the analysis of the steels used in the authors' work, including the oxygen and nitrogen. It was perhaps differences in composition which explained the varying characteristics of German and English boiler steel.

Mr. Turner replied to some of the points raised, and said he would deal with the discussion more fully by correspondence.

A paper by Mr. O. L. Aitchison and Mr. L. W. Johnson, "The Effect of Grain upon the Fatigue Strength of Steels," was taken as read.

GRAIN AND THE FATIGUE STRENGTH OF STEELS.

The report deals with the mechanical properties, particularly the fatigue strength, of steels when tested upon specimens taken parallel to, and at right angles to, the direction of elongation during forging. It is confirmed that the direction of the grain has a marked influence upon the ductility recorded in the tensile test and upon the toughness as recorded by the impact test. The maximum stress of the material when stressed in the two directions is not appreciably different. It is found that there is not such a large difference between the fatigue strength of the steel when tested in the two directions as had been supposed. It is universally found that the fatigue strength, as shown by tests on specimens cut parallel to the direction of forging, is higher than that obtained from specimens cut at right angles to this direction, but the difference between the two is not great. The maximum difference that has been found is less than 20 per cent.

The test results have been obtained by examining, first of all, a complete series of specimens, commencing with a large steel cast ingot and followed by specimens in different stages of forging, the final specimen representing a reduction in cross-sectional area of 96 per cent. from the original casting. Besides this basis series of specimens, tests have been made upon commercial mild steels, high quality nickel chromium steel, wrought irons from Staffordshire, and Armco iron.

Considerable variation has been observed in the mode of propagation of the fatigue crack in specimens oriented in the different ways. Some explanation is given of the cause of this variation.

Mr. A. G. Lobley introduced a paper, of which he and Mr. C. L. Betts are joint authors, on "The Influence of Gases at High Temperatures upon Iron, with special reference to the Formation of Blow-holes."

THE FORMATION OF BLOW-HOLES.

Primarily this investigation was undertaken to test experimentally McCance's explanation of the formation of blow-holes in iron and steel. This explanation is based on the assumption that whilst carbon monoxide is easily soluble in solid steel, carbon dioxide is very much less soluble. Both gases are assumed to be soluble in the liquid metal; hence on solidification the carbon dioxide would be expelled, forming blow-holes. If McCance be correct, it offers an explanation of the effect of the treatment in the open-hearth furnace on the steel, and its importance is therefore obvious. While attributing the formation of blow-holes entirely to carbon dioxide, McCance explains the presence of other gases in the blow-holes by assuming their diffusion from the steel into the already formed cavities.

The following conclusions have been reached:—

(1) The presence of carbon dioxide, whether by direct introduction or as a product of the interaction of carbon monoxide and iron oxide, definitely gives rise to blow-holes.

(2) In the presence of carbon monoxide the metal is very much more sound. The fact that the specimens in the carbon monoxide series were not completely free from blow-holes may be ascribed to two causes—

(*a*) Very small amounts of carbon dioxide being formed during the passage of the carbon monoxide into the furnace, and also by interaction with the small quantity of oxide in the metal; this is possibly the main cause.

(*b*) The rate of cooling adopted bringing about a state of super-saturation of the liquid metal with the gas before actual solidification.

The few blow-holes which are formed do not, therefore, detract from the comparisons made between the effects of the two gases.

(3) Mere solubility of those gases likely to be present in molten iron does not in itself cause blow-holes, ingots extremely free from blow-holes being produced in the nitrogen melts. It might be suggested that the nitrogen did not go into the metal at all, but the fact that nitrogen is soluble in molten steel has been shown by many workers from its presence in blow-hole gas, found by many workers.

(4) Hydrogen plays no part in McCance's arguments. In those

experiments, where the metal was subjected to an atmosphere of pure hydrogen, very considerable blow-hole formation resulted. A possible explanation is that the rate of cooling was too great to allow the very large volume of gas absorbed at the high temperature to escape during the liquid phase of cooling. Sieverts has shown that the solubility of hydrogen decreases rapidly with the fall of temperature, and very suddenly at the melting point. On the other hand, it may receive an explanation somewhat similar to that given by McCance for carbon dioxide. The hydrogen may react with oxide in the metal, forming steam, which either directly or indirectly by reaction with the carbon in the steel forming carbon dioxide, would form blow-holes. The carburisation of the metal in this experiment is probably the result of the direct synthesis of hydrocarbons from hydrogen and the carbon of the tube.

(5) It is seen that the temperature is an extremely important factor. This again is possibly due to the time effect in cooling already referred to, and it is just possible that, if the rate of cooling were very slow, the maximum temperature would be unimportant.

The general conclusion is reached that McCance's hypothesis is definitely confirmed by these experiments, and that whilst other factors have been shown to play a part in the formation of blow-holes under these experimental conditions, these factors, with the exception of temperature, would be relatively unimportant in steel melting practice.

Professor T. Turner said that the question raised in the paper depended firstly on the rate of contraction of the metal and the volume of gas given off during solidification in the solubility of the gases and the rate of change of solubility with changes of temperature. In the case of brass experiments had shown that a good deal depended on the method of casting. It was found that the best results were obtained when the metal was allowed to cool slowly and poured steadily so as not to entangle the gases. To some extent the same thing might be true of iron.

Dr. A. McCance referred to the suggestion put forward that carbon dioxide was less soluble than carbon monoxide, and said that in the experiments made by the authors there were too many interfering factors for that idea to be accepted as representing the facts. It was necessary to make a clear distinction between shrinkage cavities and blow-holes. The subject was one of great importance, and he hoped the work would be continued.

Dr. W. Swinden said that some of the conclusions put forward in the paper were contradictory. He assumed that blow-holes in the ordinary way were formed during the period of solidification and were due to the evolution of gases; but, contrary to the statement in the paper, there was evidence that hydrogen could not be excluded from the category of gases responsible for blow-holes. During cooling down from the liquid condition the gases consisted mainly of carbon monoxide, but there was also a considerable evolution of hydrogen, which had an influence in causing blow-holes in steel castings.

Mr. Lobley, in a short reply, said that the cooling down process in the experiments described had been carried out as uniformly as possible. It was intended to pursue the work with improved apparatus, and he hoped to extend the scope of the investigation.

The annual dinner, held on the evening of May 7th, under the presidency of Sir Frederick Mills, drew a representative gathering. The principal speakers were Mr. John Hodge, Sir William Ellis, and the President of the Board of Trade. The speeches revealed a tendency to favour a certain degree of protective legislation for iron and steel manufactures.

The Royal Society's Conversazione.

THE conversazione of the Royal Society, held at Burlington House, London, on Wednesday evening, was, as usual, distinguished by a considerable number of interesting scientific exhibits, but to a greater extent than is customary—so it appeared to us—the exhibits were of other than a mechanical or electrical nature. There was no exhibit that might strictly be classed as primarily of engineering interest.

One of the most interesting exhibits of a physical nature was that of the International Western Electric Company, which showed a number of telephotographs. These negatives and prints had been transmitted over telephone lines up to 3300 miles in length, and, as demonstrated by contrast with the originals, close inspection was required to detect that they were not direct photographs. The prints measured 5in. by 7in. and were transmitted by means of photo-electric cells, the actual transmitting time in each case being 7½ minutes. Normally, the transmitted print is really composed of a series of parallel lines, a hundred of which occupy a width of 1in. For newspaper reproduction work, an application which, we were informed, is now being tried in the United States, the lines are ruled more widely, at about forty to sixty to the inch. The original may be either a positive or a negative photograph, and if the latter may, in order to save time, be used while still wet. Other exhibits of the Western Electric Company were of a physico-medical nature, one being an artificial larynx, whereby the vocal powers may be restored to a person after the larynx has been removed; another a three-valve electrical stethoscope, permitting any number of persons up to 600 to listen simultaneously to the heart and other body sounds of a patient; and a third an electrical audiometer for measuring the sensitivity of a human ear and relating its "threshold of audibility" to that of an average ear.

The Ordnance Committee, Royal Arsenal, Woolwich, showed an instrument, designated the "trajectograph," for determining the flight of a projectile in a resisting medium. The instrument traces out the actual path of the projectile, and shows on a scale at every point the velocity of the projectile at that point. The trajectory is drawn by a knife edge or hatchet, which is guided or steered by similar hatchets, one in front and one behind, deflectable after the manner of the front wheel of a bicycle. While the movement is taking place, the front and rear hatchets approach towards, or recede from, the middle hatchet; their distances therefrom representing the instantaneous velocity.

The use of photo-electric cells of different alkali metals to detect a difference of colour in sources of light was demonstrated by the National Physical Laboratory. Before comparing the candle-powers of electric lamps photo-electrically, it is essential that they should be run with the same colour distribution, and, in order to obtain the full accuracy of the photo-electric method the colour matching must be done by a method more sensitive than the visual one. A method of colour matching has been developed by the staff of the research laboratories of the General Electric Company, and is being adopted at the National Physical Laboratory as a preliminary to the accurate standardisation of electric lamps by photo-electric methods. A rubidium and a sodium cell are connected in series, and the photo-electric currents balanced against each other when the two cells are exposed to the illumination of the same electric lamp. If the temperature of the lamp is raised, the sodium cell becomes relatively more sensitive, and *vice versâ*. By this method lamps can be colour-matched to within 1 deg. K. of the equivalent temperature and within 0.1 per cent. voltage.

Another exhibit from the National Physical Laboratory was Dr. Rosenhain's demonstration of the formation of Neumann lines in iron. Small prisms of nearly pure iron, having one vertical face polished, are strained in compression. Slow strain produces the well-known appearance of slip bands. Impact produces bands known as Neumann lines. The relation of these bands to one another disproves the view that Neumann lines are of the nature of twin lamellæ. It has further been shown that when a specimen recently deformed by slow compression is subjected to further strain by impact, no Neumann lines are formed, only some of the existing slip bands being intensified. Neumann lines are, however, again formed if the previously strained specimen is allowed to "recover" by ageing, and is then subjected to impact. The specimens exhibited showed the microscopic appearance of iron when strained in these ways.

The Laboratory also showed a portable apparatus for measuring the intensity of long-wave wireless signals, some all-metal mercury-vapour pumps, and some simple forms of carbon dioxide measuring instruments.

The Metropolitan-Vickers Electrical Company exhibited examples of chromium, cadmium and heavy nickel plating, some low impedance thermionic valves, and a noise frequency analyser. In the last-named instrument the "noise" to be analysed is picked up by a magnetophone, amplified and applied to a telephone receiver. A calibrated audio-frequency valve oscillator is arranged to superimpose on the telephone a single determinate frequency which may be varied until beats are heard in the telephone. The formation of beats indicates that the "noise" under analysis has a component frequency, which is equal to the oscillator frequency, plus or minus the beat frequency. The apparatus may be employed to determine the one or more predominant frequencies in the noise of a running machine, and from this knowledge the source of the noise may frequently be traced.

The Advisory Committee on Atmospheric Pollution showed a settlement dust counter, a new instrument designed for examining coarse dust, such as is found in the air of grain unloading stations. A column of dusty air of known height is imprisoned over a revolving disc carrying six cover glasses. The dust is allowed to settle for a measured time on each glass, or on one glass until all has settled. The number and nature of particles on a known area are then examined microscopically. Thus the dust may be graded according to rate of settlement, and the total quantity per unit volume of air found.

Among other exhibits were some examples of pure fused quartz ware, shown by the Thermal Syndicate, Ltd.; a miner's electric lamp, capable of indicating and measuring fire damp, shown by Professor W. M. Thornton; and a magazine hair break tester, shown by the Fine Cotton Spinners' and Doublers' Association, Ltd. Historical exhibits were in unusually strong force. The Admiralty Compass Observatory showed some early compasses, including one with a wooden bowl and Dr. Gowin Knight's compass of 1766, the first instrument of the kind to be patented. Early wireless apparatus was shown by the Science Museum. Among the apparatus was that used by Sir Oliver Lodge at a lecture before the Royal Institution on June 1st, 1894, in experiments with Hertzian waves when wireless signals were transmitted over a distance of some 20 yards through walls. Some illustrations of early physical instruments were shown by Professor E. N. da C. Andrade. Mr. George H. Gabb exhibited the earliest English telescope to which a date can confidently be ascribed, an instrument made of wood covered with red leather, and bearing the inscription "Iacob Cvnigham 1661."

During the course of the evening demonstrations were given by Sir Ernest Rutherford, Dr. Aston and Dr. Chadwick of an interesting French cinematograph film, illustrating the main characteristics of the Brownian motion of minute particles in liquids and gases. This motion observable under a microscope is generally held to be produced by the bombardment of the particles by the molecules of the fluid in which they are floating.

THE INSTITUTE OF TRANSPORT.

IT was fitting that in the railway centenary year the Institute of Transport should again hold its annual congress in London, having, since the last Congress here, visited Sheffield and Birmingham. The proceedings were opened at the Institution of Electrical Engineers on Wednesday morning last by the president, Sir Lynden Macassey. Two papers were then considered:—"The Ministry of Transport Requirements, 1925," by Colonel Sir John Pringle, and "Airships and their Uses both as Commercial Vessels and in Time of War," by Commander C. D. Burney. In the absence abroad of Sir John Pringle, his paper was read by Major Hall. The president took the chair at first, and was succeeded by Mr. Roger T. Smith. Alternative visits were arranged for the afternoon; one of them being to the Morden Extension of the London Electric Railways. On Wednesday evening the annual dinner was held at the Hotel Cecil, when the two successful experiments of last year were repeated with advantage; the visitors sat at small round tables and the speeches were short. The president was in the chair, and among the speakers were Sir Lynden Macassey, president; Colonel Wilfrid Ashley, Sir William Joynson-Hicks, Lord Carson, Sir Thomas Inskip, and Colonel Sir Joseph Nall. The paper read yesterday—Thursday—was by Mr. D. R. Lamb, and entitled "The Co-ordination of Rail and Road Transport." One of the visits was to the Watford branch, now under construction by the Metropolitan and Great Central Joint Committee, and to the electrically-operated signal-box of the Metropolitan Railway at Baker-street. To-day the papers to be read are:—"Arterial Roads in Relation to Town-planning," by Mr. A. E. Brookes; and "Modern Dock Equipment," by Mr. H. J. Deane. A visit will be paid to various docks this afternoon, and to-morrow to the Eastern Avenue and the new Southend-road.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

CO_2 RECORDERS.

SIR,—Will you allow me to reply to the letter by Mr. A. Dott about CO_2 recorders?

The unknown factor which Mr. Dott mentioned in his letter is now quite well known. In the older type instrument CO_2 alone was recorded, but no attempt was made to record the presence and quantity of combustible gases. The record of CO_2 alone tells you only a half truth, and as half truths they are dangerous. Let me take an example:—

The heat loss at 10 per cent. CO_2 may be either 16 per cent., or, if there are combustible gases present, the loss may be 35 per cent., hence the necessity for having two records on every CO_2 record, namely, a record of the carbon dioxide, and a record of combustible gases. The art of firing is to find the "critical point," namely, where the CO_2 is at its highest, and no combustible gases present.

Mr. Dott must bear in mind that all these instruments are means to an end. They are in a different category from appliances, such as economisers, superheaters, air heaters, &c. They are more like the doctor's stethoscope and thermometer. They help to diagnose the illness, but are useless for the cure unless there is sufficient skill to act on the diagnosis.

It is the lack of this skill which costs this country millions a year in inefficient boiler plant, and it is not due to any lack of intelligence on the part of the engineer, but simply owing to the unwillingness of the boiler user, as a rule, to pay a proper and adequate salary for such skill. I once advocated the institution of a school for stokers, and wrote a long memorandum to the Board of Trade on the subject, but was politely informed that the matter was of no interest at all. Before we settle down to a determined effort to teach stokers, and the boiler-house foreman in the technique of combustion in all its phases, we shall never make any progress. The human factor is in this matter as in all matters the all-important one.

J. J. LASSEN.

London, May 12th.

NORTON AND GREGORY ENGINEERING SCHOLARSHIPS, 1925.—The following scholarships, total value £450, have been awarded by Norton and Gregory, Ltd., Castle-lane, Buckingham Gate, London, S.W. 1:—To Arthur Aylwin Fletcher-Jones, Monkton Combe School, near Bath, £100 per annum tenable for three years at Cambridge University; and to Richard Peter Alston, Clifton College, £50 per annum tenable for three years at Cambridge University.

JUNIOR INSTITUTION OF ENGINEERS.—The annual dinner of the Junior Institution of Engineers was held at the Monico Restaurant on Wednesday, the 13th, Dr. Alexander Russell, the president, being in the chair. There must have been nearly 200 members and guests present, and Mr. W. A. Tookey, with his usual enthusiasm and the Institution's gilded hammer, undertook the task of introducing many of them to the company by calling on the chairman to take wine with them in turn. The toast of the Institution was proposed by Mr. J. S. Highfield, the president-elect, and was responded to by Mr. H. J. Edgar. Mr. A. P. M. Fleming proposed "The Electrical Engineers," in a most humorous speech, to which reply was made by Dr. Russell. The guests was proposed by Mr. L. M. Jockel, and was replied to by Sir W. Sefton Brancker, who urged the vital necessity for the development of our commercial air services, and by Sir Charles L. Morgan. The toast of the chairman was proposed by Mr. Hewitson Hall. During the evening some songs and amusing anecdotes were provided by Messrs. Norman Long, David Openshaw, Geoffrey Duprée and Bernard Flanders.

The Bow Power Station.

LIKE many other electric generating stations that were built in the past, the Bow Station of the Charing Cross Electricity Supply Company, which was originally a reciprocating engine station, has been reconstructed, and the capacity and efficiency of the plant have been materially increased. The work was begun in 1914, but in consequence of the war, no real progress was made until 1919, when the problem of providing an adequate supply of condensing water was first considered. To safeguard the vacuum conditions of the station, a second set of cooling towers, capable of dealing with a million gallons of water per hour was added to the existing set of towers of the same capacity, but as the site—see Fig. 1—could only accommodate a further small addition to the cooling plant, the engineers were compelled to seek another solution to the problem. At the back of the station there was a partially silted up branch of the river Lea, known as Pudding Mill Creek, which was dry at low water and only filled at high water. Permission was sought and obtained from the Lea Conservancy to build a dam across the Pudding Mill Creek, opposite the power station, an undertaking which involved making a new set of lock gates—as shown in Fig. 2—in the Lea itself, and digging out Pudding Mill Creek for a distance of some 900 yards to the river Lea. In this way locked water was brought close to the power station, and by means of four 27in. pipes, water is now conveyed from the Creek across a road into a 48in. bus-pipe in the company's ground. This bus-pipe runs into a pump house containing four pumps, which pump the water through strainers into the tanks of the existing cooling towers, which form the suction chamber for the circulating pumps, whilst the discharge from the pumps returns by way of a 54in. pipe into Bow Bank River, which is another branch of the Lea. As shown in Fig. 1 the whole system forms a loop which is some 3 miles long. By extending the pumping plant and with the added capacity of the two cooling towers mentioned, from 6 to 7 million gallons of water will be made available.

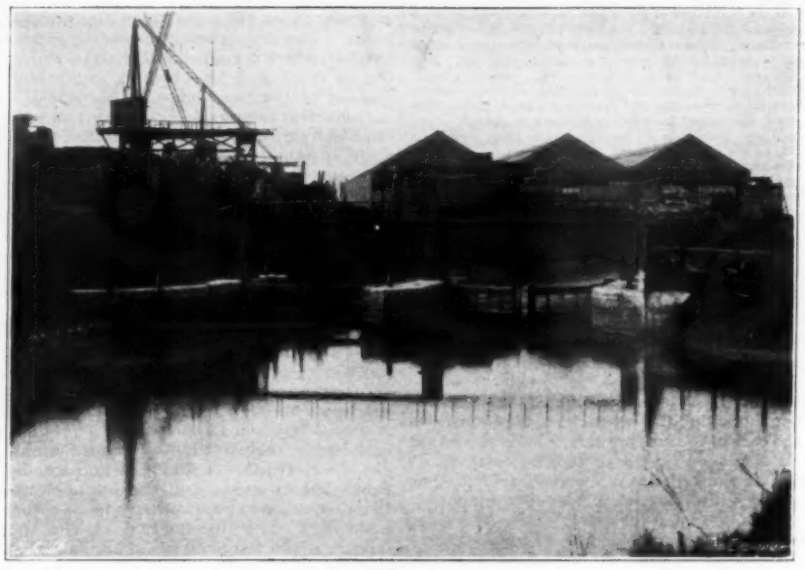


FIG. 2—NEW LOCK GATES ON THE RIVER LEA

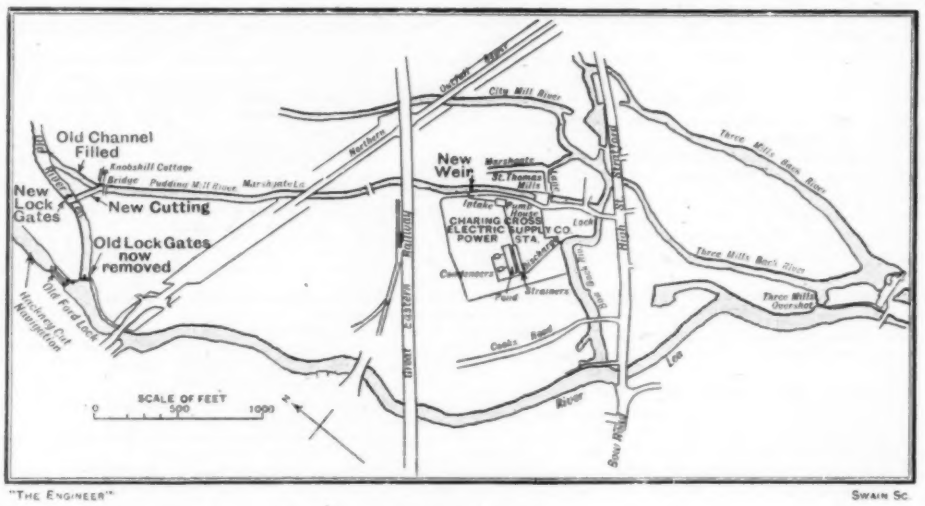


FIG. 1—PLAN OF THE SITE

Having grappled with the circulating water problem the engineers then turned their attention to the steam pressure, and it was finally decide to raise the original pressure of 175 lb. per square inch to 265 lb. per square inch, and to increase the total temperature from 540 deg. Fah. to 650 deg. Fah. In the old boiler-house there were originally fifteen horizontal Hornsby boilers, set in pairs between the building stanchions, each having an evaporative capacity of 20,000 lb. There were also three vertical Hornsby boilers which occupied the whole space between a single pair of stanchions. The latter boilers were installed by Mr. W. H. Patchell in the year 1900, and at that time they were the largest boilers in the world, having unusually high and roomy furnaces. Two of these boiler units were originally set back to back, and they were run as single units, the combined evaporative capacity being 100,000 lb. of water per hour. At a later date a dividing wall was built to enable the boilers to be run separately as 50,000 lb. units. As regards the height of the furnace and other essential characteristics, these boilers closely resembled prevailing American practice. The boilers ran without intermission for thirty years, and were only dismantled in consequence of the change in steam pressure. They evaporated per unit of space practically the same amount of water as boilers installed in these days, and Mr. Patchell's decision to use such steam-raising units so many years ago was undoubtedly a very wise one.

Each of the new boilers occupies the space available between a pair of stanchions in the boiler-house. There are seven boilers of the Babcock and Wilcox C.T.M. type, and two Spearing boilers, the normal evaporating capacity of each being 55,000 lb. of water per hour, at a pressure of 265 lb. per square inch and at a total temperature of 650 deg. Fah., superheaters and economisers being fitted to all the units. A view of the boiler-house is given in Fig. 6 on page 546.

In the reconstruction of the station two other matters called for consideration—the provision of new alternating current Reyrolle switchgear with a much greater capacity than that of the old gear—and the re-arrangement of the feed heating system. The conditions existing did not permit of the adoption of the closed feed system, and for similar reasons it was not possible to bleed the turbines. Two auxiliary 1000-kilowatt turbines with jet condensers were installed—see Fig. 3. The whole of the condensate from the main turbines is taken into a large tank termed the intermediate tank, and from this tank the water is sucked by the vacuum into the jet condensers of the auxiliary turbines, the discharge being turned into the hotwell. It was calculated that the average temperature of the condensate would be about 90 deg. Fah., and it was desired to keep the hotwell temperature at about 150 deg. From the hotwell the water is therefore pumped by lift pumps to a head tank situated on the top bunker floor, whence it falls by gravity to the feed pumps, and two sources of heat are used for supplying additional heat to the head tank water. The exhaust steam from the feed and lift pumps is discharged through nozzle heaters into this tank, and the water from the hotwell passes through a spray cooler, where it mixes with and condenses the vapour from the feed water evaporators, the calculated temperature of the head tank being 200 deg. Fah. A diagram of the system is shown in Fig. 4. An electrical system of control for the temperatures of the hotwell and head tank is provided, and it forms part of the auxiliary supply system.

In order to facilitate restarting the plant in the event of a total shut-down of the station, two independent sets of bus-bars and two sources of supply are provided for the auxiliary service. These sets of bus-bars are arranged one above the other, the top set being supplied by two 1000-kilowatt motor generators, connected on the alternating-current side to the 10,000-volt main bus-bars, whilst the lower direct-current bars are supplied by the two 1000-kilowatt turbo-generators. Although the two sets of bus-bars are entirely independent, by means of the double-throw circuit switches the circuits may be

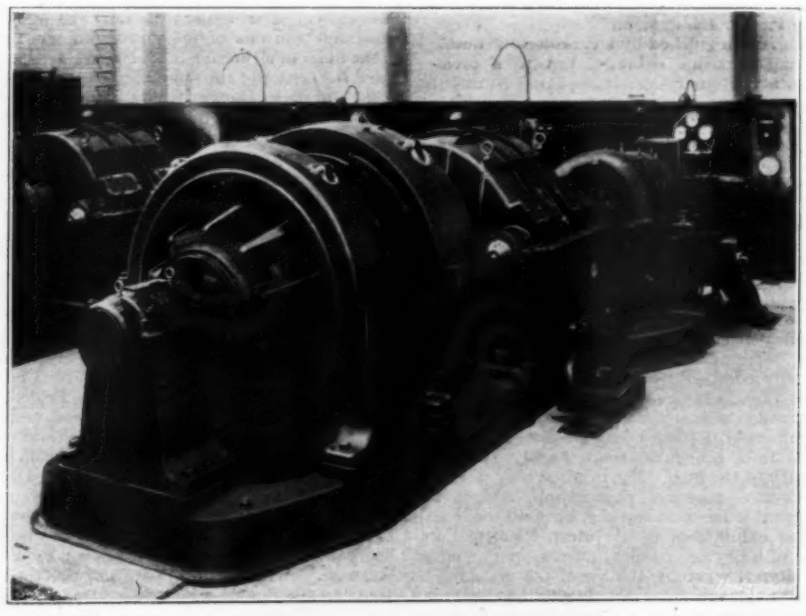


FIG. 3—1000-K.W. AUXILIARY TURBO-GENERATOR

connected to either set of bars. On the switchboard gallery indicating temperature meters are provided to enable the variations in temperature of the hot-well or head tank to be observed, and the control switching arrangements can be operated accordingly.

In the boiler-house there is an elaborate equipment of measuring instruments, indicating instruments being fixed on the boiler fronts, whilst integrating and recording instruments are grouped in a separate room. Each boiler is also provided with a Lea coal

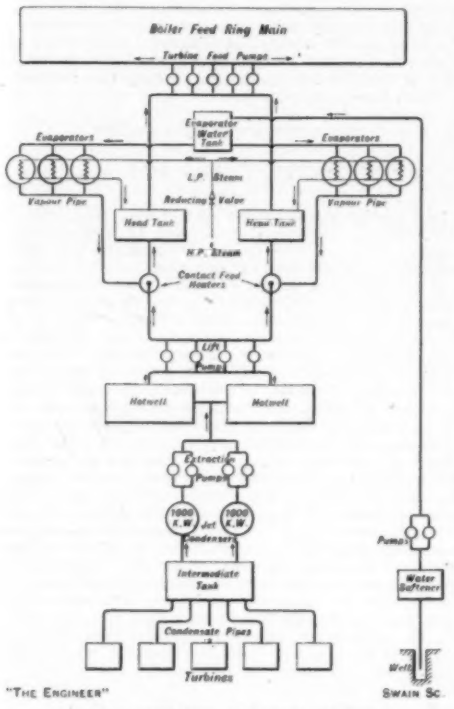


FIG. 4—DIAGRAM OF FEED SYSTEM

meter, a steam-flow indicator, draught indicators and CO_2 indicators, whilst in the pump room there are two large indicators, one for measuring the total amount of water pumped into the boilers and the other for measuring the make up. The central instrument room contains recording CO_2 meters for each boiler, steam-flow integrators and recorders, and flue gas and feed-water temperature indicators. Each turbine also has a stop valve temperature indicator, vacuum recorder and circulating water inlet and discharge indicators.

There is still space in the engine-room for two more 16,000-kilowatt sets, and when they have been installed the total capacity of the plant will be 85,000 kilowatts. The following table gives the steam consumption of the turbines at their most economical load, in the order in which they were installed :—

No.	Kilowatts (maximum continuous rating).	lb./kwh at 80 per cent. load.
14	6,000	14.9
3	6,000	13.7
4	12,500	10.72
5	12,500	10.7
6	16,000	10.03

The cost per kilowatt of the whole of the new plant

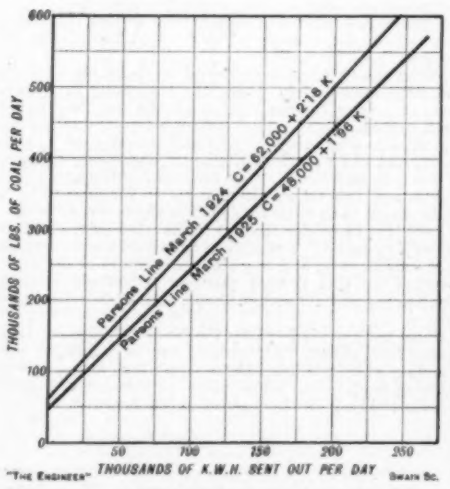


FIG. 5—COMPARISON OF PARSONS' LINES

was £15, and with two additional sets of 16,000 kilowatts and corresponding boilers purchased at prevailing prices, the cost for the 85,000-kilowatt station will not exceed £13 per kilowatt, inclusive of all foundations and additional building work, but not exclusive of the original buildings. The alterations which have been carried out show in a very striking manner the great difference in the efficiency of the original reciprocating sets, and that of the new steam turbines. In 1914 the coal consumption per kilowatt-hour delivered to the feeders was 4.8 lb., whereas in 1924 it had fallen to 2.42 lb. The progressive increase in efficiency from 1921 is shown in the following table :—

Year.	B.Th.U. per kilowatt-hour delivered to feeders.	Thermal efficiency of station, per cent.
1921	38,860	8.78
1922	36,884	9.23
1923	28,791	11.86
1924	23,340	14.6

The figures for 1925 will, we understand, show a substantial improvement on those for 1924, for even in the latter year a certain amount of reciprocating plant had to be run. Moreover, the feed-heating system was only put into operation during the last month or two, and that adds considerably to the thermal efficiency of the station. The Parsons lines for the station for the month of March, 1924, and for March of this year are shown in Fig. 5, the thermal efficiency for the latter month being 16.08 per cent.

The whole of the charges in generating plant and boilers and in switchgear were carried out continuously and without any interruption to the supply, a feat which reflects great credit on the staff. On page 546 we give illustrations of the newly equipped engine-room and boiler-house, also a view of the circulating water strainers and Allen circulating pumps.

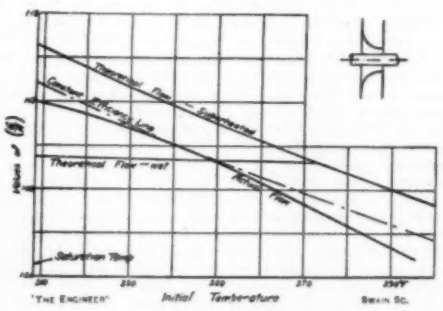
The view of the turbine room shows two 12,500 kilowatt Fraser and Chalmers English Electric sets, a 6000 kilowatt Parsons set, and a 6000 kilowatt English Electric unit.

For the information contained in this article, we are indebted to Mr. J. S. Highfield, the consulting engineer.

Supersaturation.*

AN account of experiments upon steam flow would be incomplete if reference were not made to the occasionally observed phenomenon of "excessive discharge." Some years ago it was noticed that, in many quite simple nozzle experiments, flow quantities were obtained in excess of those calculated on the assumption of isentropic expansion of saturated steam. It is obvious that the actual flow ought to be less than the theoretical, since any type of loss or imperfection in the expansion must reduce the discharge below the ideal value. Doubts were, therefore, cast upon the soundness of the underlying theory. It should be recognised that this "excessive discharge" occurs only with wet steam or with steam which, according to the ordinary conception of vapour, would become wet during expansion. With the particular examples of steam flow already given in this paper, the steam would remain superheated throughout, and, in fact, the coefficient of discharge was always less than unity.

The explanations offered to account for this excessive



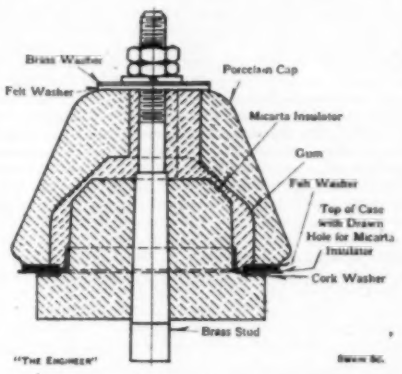
CURVES OF FLOW

discharge are based upon the assumption that rapidly expanding steam may be in a state of supersaturation. That is to say, the ordinary function of condensation is, for the time being, suspended and the fluid operates simply as a cold gas. In other words, instead of the expansion following the law $P V^{1.3} = C$—which gives the approximate relationship between pressure and volume for steam expanding in the normal condition without loss of heat—it follows that represented by $P V^{1.13} = C$. The development of this idea is interesting, since the possibility of the supersaturated state was first shown by Aitken in his experiments on fog formation. Its first application to heat engine work was made in 1897 by Callendar and Nicolson, who indicated the possibility of its occurrence in steam-engine cylinders and showed that it involved a definite loss which could account for a certain portion of the "missing quantity." In the steam nozzle field the first to recognise the possibility of supersaturated expansion was Lorenz in 1903. The suggestion was examined by Stodola, who pointed out that the conception involved excessive discharge and since, at that time, there was no clear evidence of this phenomenon he was led to believe that the occurrence of supersaturation was unlikely in nozzle expansion. With the definite establishment of the fact of excessive discharge in nozzles passing saturated steam the idea of supersaturation was independently and successfully resurrected by Martin, in 1913, and placed in a sound position as an important influence modifying the ordinary expansion theory used in turbine design.

The effect of supersaturated expansion upon the steam discharged in nozzle flow is shown in the diagram. The experiments here refer to those obtained from a simple convergent nozzle, using a steam pressure of about 76 lb./in.² abs., and different degrees of superheat. The base line represents the initial temperatures of the steam, and the ordinates show the amount of steam discharged per second for each square inch of nozzle area. The upper curve, marked "Theoretical Flow-Supersaturated," is calculated from equation (1) on the assumption that the law of expansion throughout the whole range is $P V^{1.3} = C$. The curve gives, therefore, the flow for initial states varying from dry to about 100 deg. Fah. of superheat under the theoretical conditions of no energy loss and complete supersaturation. The lower curve, marked "Theoretical Flow—Wet," is calculated on the usual assumption of stable expansion of wet steam. The point at which it meets the upper curve represents that degree of superheat which ensures that the whole expansion beyond that temperature will be in the superheat field. It will be noticed that, in both cases, increased superheat involves diminution of steam flow. The actual observations are shown on the line of "Actual Flow," and by comparing this with the theoretical flow curve for wet expansion, the condition of "excessive discharge" is clearly seen. Little doubt will be felt that the upper line of theoretical flow represents the more correct theory, and that the discharge is excessive only because the ordinary basis of calculation is quite wrong. An interesting feature of this diagram is the relationship that exists between the actual flow curve and the line marked "Constant Efficiency." From this it will be observed that above 345 deg. Fah. there is a small but definite decrease of efficiency with increase of superheat. Below 345 deg. Fah. the expansion losses again appear to increase, and the explanation put forward† is to the effect that this indicates a slight degree of reversion to the wet state during expansion.

Static Condensers for Power Factor Correction.

THERE is a tendency in America on the part of the electric power companies to distribute power at a pressure of 4000 to 5000 volts, and there is also a greater inclination than in the past to enforce the power factor clause which is to be found in the contracts of all the large supply companies. An increased demand for power factor correcting apparatus has therefore arisen, and in view of the higher voltages that are coming into use, static condensers appear to be gaining favour. Formerly, these condensers were



SECTION THROUGH OIL-TIGHT BUSHING

made for operation on 2300-volt circuits, but a new design for the higher pressure of 5000 volts has been developed, and is described by Mr. R. A. Lane in the February issue of the *Electric Journal*, published by the American Westinghouse Company.

The problems involved in the design of the 5000-volt units do not differ very much from those associated with the design of the lower voltage condensers. As the operating voltage increases, however, the capacity in microfarads required to draw one leading kilovolt-ampère decreases in accordance with a square relation. Thus, while the capacity per kilovolt-ampère at 2300 volts is 5 microfarads, at a pressure of 4600 volts it is .125 microfarad. Assuming a constant voltage stress per mile of insulation thickness, the volume of active insulation per kilovolt-ampère remains constant, regardless of the applied voltage. The insulation in a 4600-volt condenser is twice as thick as it is in a 2300-volt unit working at the same stress, but since only half the area is required, the volume is constant.

In all the units the voltage is applied to the dielectric in such a way as to ensure even voltage distribution throughout the dielectric. The elements are made up of alternate layers of laminated paper dielectric and tinfoil, the latter being, of course, narrower than the paper, so as to provide the requisite clearances. The paper and foil are cut on a special machine, and the material is then stacked in a fixture so that alternate layers of the foil project at opposite ends. For the outside plates, tinned sheet copper is used to give stability and to facilitate the soldering operation, which reduces the lead foils which protrude on either end to a solid mass, to which leads are attached in assembling the groups.

This operation is performed in a fixture which applies a definite pressure to the unit during the operation, and is reversible, so that both ends of the section may be soldered without removing the work from the machine. These sections are grouped together to form a unit of proper size for assembly in the sheet metal case, which is made of terne plate, the top being a separate piece which is soldered in after the condenser element, with its insulation, has been assembled in the case. This top piece is provided with two drawn tapered holes for bushings, and also a central hole for impregnating purposes, and into which a threaded brass bushing is soldered. Leads are brought out through the oil-tight bushing, a section of which is shown in the accompanying drawing. The central brass stud, it will be noticed, is tapered and fits

* From a paper by Professor A. L. Mellanby, read at a meeting of the Institution of Chemical Engineers on March 11th, 1925.

† "The Supersaturated Condition as Shown by Nozzle Flow," "Proc." Inst. of Mech. Eng., 1922.

into a taper-reamered hole in the micarta insulator, so that when the protective cap of porcelain is put on and the nut on top is tightened, the stud is drawn into the micarta and the latter is drawn up into the tapered hole in the cover.

Gum is then poured in to fill the space between the cap and the micarta insulator. In the case of accidental breakage, the porcelain cap may readily be replaced on site without damaging the condenser. When the cover has been soldered on, the box serves as its own vacuum tank for impregnation purposes. The impregnation process is carried out with two main objects in view—the removal of moisture from the condenser section itself and the insulation which is placed between it and the metal case, and, secondly, with the object of completely impregnating all the material with oil.

The removal of moisture from the insulation is accomplished by heating the units in ovens to a temperature of somewhat above 100 deg. Cent., and at the same time maintaining a vacuum of 28in. or more on the units. The heat vaporises the moisture. The process is checked by passing the gases removed through a condensing chamber and by measuring the rate at which the moisture is removed. When all the moisture has been abstracted, the vacuum is maintained, whilst the treated oil is slowly run into the units until they are filled.

The vacuum is then cut off and the units are allowed to cool down under a head of oil. When they are cool, they are removed from the oven and are sealed. In addition to various tests and inspections carried out in the course of manufacture, each complete unit is subjected to a dielectric loss test, an earth test, an over-voltage test, and a capacity measurement. Dielectric losses are made to be less than .5 per cent. of the working kilovolt-ampères of the equipment. The dielectric losses are measured by correcting the power factor of the unit under test with an inductance, the losses in which having been obtained very accurately with a special type of wattmeter. The total losses in the resonant circuit are measured with a wattmeter, and the condenser losses are obtained by subtracting the known inductance and meter losses. The use of the calibrated inductance renders it possible to employ ordinary precision instruments.

All the units are tested in accordance with the American Institute of Electrical Engineers test for switching equipment, which calls for a voltage 2.25 times the rated voltage plus 2000 volts for one minute. The pressure is raised slowly from below the rated value, and is maintained at its maximum value for a period of one minute. The voltage variation is obtained by varying the field strength of a 2300-volt generator, which feeds the testing transformer. On an average the units are found to break down at about twice the value of the test voltage. On account of the liberal design of these condensers, they can be operated at a voltage 10 per cent. above the rated voltage for a considerable period, and as the volt-ampère capacity increases as the square of the voltage, a 21 per cent. increase in the kilovolt-ampère capacity is obtained.

The condenser units are assembled in angle iron frames, which are designed to take 18, 30, 48 or 60 units for either indoor or outdoor service. Those for indoor use are provided with expanded metal screens, and a flat top, whilst those for outdoor use have sheet metal sides and a sloping roof. Each frame is a complete unit in itself, the circuit breaker being mounted either on the front plate or on a pipe structure, depending on the size and type required for the particular job. The circuit breaker has a series of trip coils, which open the circuit in case of trouble. Leads are run from the circuit breaker to the bus-bars, which are mounted on 7500-volt pillar insulators on the rear of the front plate.

Cable connections are made between the bus-bars and the units, whilst the connections between the units are arranged so that by changing one connection on each phase any desired number of units may be disconnected, so that the corrective capacity may be changed with seasonal changes in load and power factor. When more than 300 kilovolt-ampères are required two or more units are used.

As the condensers retain their charge for a long time after they have been disconnected from the line, a high-impedance coil is permanently connected across the condenser terminals, and this coil dissipates the energy in the condenser when the circuit breaker is opened.

The cost of maintaining apparatus of this kind is insignificant, for there are no moving parts, and the apparatus does not require periodic overhauling. Moreover, no attention is required, for after an interruption in the supply the apparatus automatically resumes its duty.

The History of Bryan Donkin and Co.

THE first Bryan Donkin was a man of varied attainments. He was born in 1768 at Sandoe, Northumberland, his father being the land agent to several large estates in that county, and at the age of twenty he himself was agent to the Duke of Dorset at Knowle Park, Sevenoaks. But the work did not appeal to him, and he bound himself for three years to John Hall, of Dartford, a millwright, who had a connection with the paper-making industries. As soon as he was out of his time young Donkin started in business in Dartford on his own account, and was joined by Davis and Marshall. But he retained his friendship with John Hall, whose firm, carried on by his sons, became the J. and E. Hall which exists to this day.

Through this early connection with Hall and paper-making Bryan Donkin became interested in the Foudrinier paper making machine; and took over a factory at Bermondsey which had been set up for the manufacture of the machine. The same connection brought him into touch with Richard Mackenzie Bacon, of Norwich, with whom he collaborated in the invention of a rotary printing press in 1813. A few years before that date he had patented and practised a method of making steel pens, and about the same time he, with Hall and Gamble, purchased for £1000 the rights in a process for preserving meat which after various difficulties gained considerable success. Business did not flourish in the early days of the nineteenth century, when the war with France was drawing to an end, with results not unlike those of to-day. Hence Donkin had to look for other work and engaged in a good deal of civil engineering of one kind and another.

Amongst the many notable men with whom he was associated mention must be made of Congreve of war-rocket fame, who brought his invention of a machine for printing in two colours to the firm, and Babbage, for whose calculating machine Bryan Donkin and Co. carried out much of the work. In 1846 he retired from the business, which he left to his sons, and in 1855 he died at the age of eighty-seven.

His son Bryan followed in his footsteps, but his grandson, "Bryan Donkin, junior," the son of his eldest son John, is best known to engineers. He took a keen scientific interest in the steam engine, and it is to him that we know, through the "revealer," much about the condition of steam in steam engine cylinders. He wrote a good deal for our columns, and especial reference may be made to a table of steam engine tests which appeared in THE ENGINEER of October 13th, 1899. He it was who brought the firm into touch with the gas industry.

In 1902 the firm decided that the Bermondsey works were unsatisfactory, and it removed to Chesterfield just after the conclusion of a century in London. The new works belonged to Clench and Co., Ltd., and after the amalgamation the firm was known for some years as Bryan Donkin and Clench, Ltd., but subsequently took the style of The Bryan Donkin Company, Ltd., by which it is now known.

We take these notes from a very interesting little brochure, which has been written by Mr. Harry J. Donkin, who is a grandson of the founder of the company, and is in charge of the London office of the firm, whilst a great-grandson, Cyril Bryan Donkin, is in charge of the Midland district.

BOOKS OF REFERENCE.

The Empire Municipal Directory and Year Book, 1925–1926, has just made its welcome appearance. This year it is in its forty-third annual issue, and it contains, as usual, a very large amount of information which is likely to be of value not only to the municipal engineer—to whom the book is intended specially to appeal—but to other engineers as well. In form, the new issue is identical with that of preceding years, and we notice that, as far as it has been possible, the same matters are dealt with on the same pages as in former issues—a feature which will be appreciated by all who have to use books of reference frequently. The general articles on Road Construction and Maintenance, Plain and Reinforced Concrete, Lighting, Heating and Ventilation, Water Supply, Purification and Softening, Sewerage and Sewage Disposal, Fire Prevention, &c., have been entirely re-written, so as to bring them up to date, and the names of officials, addresses, telephone numbers, have been corrected right up to the moment of going to press. We see that, this year, there is a Foreword by Sir Henry Maybury. The "Directory" is published by *Municipal Engineering and the Sanitary Record*, 8, Breams-buildings, Chancery-lane, London, E.C. 4, price 11s. post free.

"The Electrician" Annual Tables of Electricity Undertakings, 1925, published by Benn Brothers, Ltd., 8, Bouverie-street, London, E.C. 4. Price 10s. In the preface to this, the thirty-eighth edition of these tables, it is stated that hitherto they have been issued from time to time in the *Electrician* in the early months of the year, but now they are published independently in one cover annually on May 1st. It is claimed that considerable advantages accrue from this departure, inasmuch as the accounts of work of the electric supply companies are made up to December 31st each year, while the financial year of the Local Authorities, except those in Scotland, ends on March 31st. The tables issued in the present volume have, we understand, been thoroughly revised, and further details have been added. Particulars of over one hundred additional undertakings in Great Britain, Europe, the Overseas Dominions and foreign countries are included, while complete lists of smaller undertakings in Yugo-Slavia and Roumania are given for the first time. Altogether, some 2000 undertakings are dealt with, and the new edition has been expanded by twenty pages.

The Manchester Royal Exchange Directory, 1925, forms the thirtieth edition of this book of reference, which is issued with the sanction of the Directors of the Exchange, and which is obtainable from John Heywood, Ltd., of Deansgate and Ridgefield, Manchester, and 20–22, St. Bride-street, London, E.C. 4, price 21s. net. The book is so well known and so often consulted by those for whose use it is specially intended, that it will be hardly necessary for us to refer to its contents, but we may say that, among other things, it contains, in addition to full particulars and a short history of the Exchange, an alphabetical list of the firms represented by the members of the Exchange, an alphabetical list of the members and the firms to which they belong or which they represent, an alphabetical classification of cotton spinners and manufacturers, cotton doublers, cotton waste spinners and manufacturers, and cotton manufactured goods; and a classification according to towns of cotton spinners and manufacturers, doublers, bleachers, dyers and finishers, &c.

The Port of Hull Annual and Humberside Commercial Review, 1925, contains a vast amount of information, not only of the town of Kingston-upon-Hull—to give it its full title—but also of the other Humber ports of Grimsby, Immingham and Goole. There are data concerning the trade in coal, wool, fishing, grain, provisions, hides, seed oil, fruit, timber, shipbuilding, &c. &c., and full details as to the dock and quay facilities and equipment at the various ports. The inland water transport facilities are also discussed at considerable length. The book is, in fact, a regular storehouse of information, and, to add to its utility to foreign traders, there are chapters in French, Italian and Spanish. It is edited and published by Mr. H. E. Cooper Newham, of Hull, and is obtainable, price 3s. 6d. net, from the office of the *Port of Hull Monthly Journal*, Bishops-lane, Hull.

The Sweden Year Book, 1925, is an official publication, which is issued by Almqvist and Wiksells Boktryckeri-A.-B. It is a book of reference, written in excellent English, which contains information of a most varied character. There are particulars of the Royal Family, the Constitution and the Cabinet; lists of Swedish legations and consulates abroad, and foreign legations and consulates in Sweden; of finances, national defence, education, population, &c.; of natural resources, trades and industries, agriculture, mining, foreign trade and shipping, and a whole host of other things too numerous to particularise. The book is well got up and illustrated, and should certainly prove of considerable value to those having business with or desiring information concerning this interesting northern European country.

SIXTY YEARS AGO.

IN a leading article in our issue of May 12th, 1865, we discussed the widespread possession of mechanical ingenuity and the very great restriction of engineering judgment. Let any kind of mechanical question be placed plainly before the public, we wrote, and thousands of answers will be very quickly given in reply. As an example, we instanced the then prevailing need for the provision of some means of communication between the passengers and guards of railway trains. Following outrages and accidents, which, it was held, might have been avoided if means of communication had existed, the public at the moment was greatly agitated over this matter, and the railway directors' apparently cynical indifference to its demand. A Railway Clearing House Committee had been appointed to consider the question, and had received nearly 200 suggestions for the purpose. Our own life, we recorded, had become almost a burden to us by reason of the number of letters received from correspondents of both sexes and all professions and ages, containing suggestions for the solution of the problem. While the sanguine confidence of the writers approached the sublime, their schemes were generally ridiculous. A similar flood of "impotent ingenuity" had broken loose when years previously an official inquiry was undertaken into the adoption of improved means for preventing the forging of bank notes. One hundred and seventy-eight schemes were submitted to the Committee of Inquiry, but only twelve had a practicable look, and but nine were stated to deserve careful examination. The same story could be extracted from the records of the Patent Office. Little more than 2 per cent. of the three to four thousand patents granted each year attained full growth, and paid all the stamp duties. The truth was, we wrote, that while the power of "scheming" was not uncommon, the power of really inventing was rare. Invention was the poetry of science, and in the mechanical as well as in the other art, there were poetasters as well as true poets. It would do much good, we argued, if there were a general comprehension of the fact that the power of forming mechanical combinations was common to many minds of a by no means high order. Recognition of this circumstance would prevent many people leaving the ordinary occupations which they understood and entering the arena of competition with trained mechanical intellects. The warning seems no less necessary to-day than it was in the definitely less mechanical days of sixty years ago.

A NEW LOCK NUT.

WE have received from Herbert Terry and Sons, of Redditch, some samples of a new type of lock nut which, if it has no other merits, must at least be very reasonable in cost. It is made by folding a piece of steel plate so that there is a slight gap between the two folds, and the outline is the familiar hexagon. A projecting lip on one of the facets is also bent over, so that its edge comes flush with the face of the opposite fold. The composite nut thus formed is threaded to the proper pitch of the bolt, but the thread is 3 deg. out of square with its face. The metal of which the nut is made is, by the way, harder than that generally used for bolts.

When the lock nut is tightened on to an ordinary nut, the edge immediately under the projecting lip touches first, and upon further tightening, the nut tries to seat itself square. At the same time the top face of the lock nut inclines toward the bottom and is forced out of alignment, and has the effect of slightly depressing the screw of the bolt, and jamming the lock nut. Although a slight dislocation has taken place, it is so imperceptible, we understand, as to cause no defect to the screw, although it is sufficient to render the nut immovable even under the severest vibration. The nut can be removed with a spanner in the usual way, and any slight distortion of the bolt is rectified by this inverse process. Upon removal, the lock nut resumes its normal shape, and is ready for further service.

Some tests carried out by the National Physical Laboratory have shown that this lock nut is capable of withstanding over 6½ million blows within 70½ hours, without slacking back, while a test made by Faraday House was run for 100 hours without effect on the nut.

FIFTY YEARS OF YACHT DESIGNING.—We received recently from G. L. Watson and Co., naval architects, of 153, St. Vincent-street, Glasgow, a handsomely bound souvenir booklet in which the work of the firm during the fifty years 1873 to 1923 is reviewed. A brief account is given of the racing yachts, steam yachts, and motor vessels built to the designs of the firm, and some excellent engravings of representative yachts are reproduced. The firm has in recent years been prominently associated with lifeboats, as both the late Mr. G. L. Watson and Mr. J. R. Barnett—the present technical principal—have acted as consulting naval architects to the Royal National Lifeboat Institution. The evolution of the lifeboat from the sailing type to the latest motor lifeboat is described and illustrated. This booklet is printed for private circulation only.

Railway Matters.

A SERIOUS disaster occurred recently to the Konisberg-Berlin express whilst it was travelling through the Polish "corridor," and a score or more passengers were killed. The Polish railway officials claim that the track was maliciously interfered with, but the German authorities allege that the line was badly maintained.

THE chairman of the Pullman Car Company stated, at the recent annual meeting of that concern, that from July 13th the "Harrogate Pullman," which now runs between King's Cross and Newcastle, will operate between King's Cross and Edinburgh. It was also intimated that third-class Pullman cars are to be introduced on the Great Southern Railway of Ireland, which is a grouping of all the railways in the Irish Free State.

THE Furness Railway Company, after nearly sixty years' service, placed its old engine Coppernob in a glass house on the down platform at Barrow-in-Furness station. It was built in 1846 and has now been temporarily removed in order to be exhibited at Wembley. Another exhibit at the British Empire Exhibition is the model railway from the signalling school at Victoria Station, Manchester, London, Midland and Scottish Railway.

IN furtherance of the extensive scheme of improvements upon which it has embarked, the London, Midland and Scottish Railway have decided to convert from a 16-ton to a 20-ton capacity seven balance-weight coal tips at Garston Docks. In addition, there are six hydraulic coaling hoists of 30 tons gross capacity. As a further step in the improvement of facilities for coal export, the L.M.S. is carrying out experiments with a view to obviating breakage in the shipment of coal by hydraulic hoists.

THE relations between the Great Western Railway and the National Union of Railwaymen in respect of the necessity for reducing the staff in South Wales would appear to have taken a happier turn. It will be remembered that the Union objected to the question being considered, as proposed by the company, by the sectional councils, but a statement issued by Mr. Cramp on the 8th instant indicated that the men now agreed to that course being taken. The statement concluded :—"It is hoped that a satisfactory solution of the difficulty will be arrived at."

THERE are many features in the Railways Act, 1921, that are a positive boon to the railway companies, the most important probably being that contained in Section 58, which practically guarantees the companies the equivalent of their annual net revenue of 1913. Another valuable concession is contained in Sections 16, 17, which allows the Minister of Transport, on the application of a railway company which wishes to effect alterations, extensions and improvements of existing works, to issue an Order sanctioning such work. Then, if land or easements be required, an Order to acquire them may also be issued. This procedure is not only less costly to the companies than which existed formerly, inasmuch as an Act of Parliament was then necessary, but it is more expeditious.

IN our obituary notice on April 10th of Sir William Acworth it was observed that had the minority report of the late Mr. A. H. Smith been adopted the Grand Trunk Railway might have remained in existence and the Canadian Pacific Railway would not have had to compete with the railways owned by the Canadian Government. In that connection it is interesting to see the Toronto correspondent of *The Times* cabling recently :—"A serious movement has begun for the reduction of the railway service and greater co-operation between the Canadian Pacific and the National system. Public opinion is disturbed over the continuing National deficits and the costly competition with the Canadian Pacific for goods and passenger business, and there is an increasing demand that both systems should eliminate the duplication and operation of services in excess of traffic needs."

IT is officially announced that Mr. Gilbert S. Szlumper has been appointed, as from the 1st inst., assistant general manager to the Southern Railway. Mr. Szlumper is the son of the chief engineer to that company, and for thirteen years occupied various positions in the engineering department. In 1914 he went to Sir Herbert Walker as an assistant, and thereby became secretary to the Railway Executive Committee, which administered the railways on behalf of the Government from August, 1914, to December, 1919. Just before the latter date Mr. Szlumper went to Southampton in order to succeed Mr. T. M. Williams, when that gentleman retired from the position of docks and marine manager. On the formation of the Southern Railway his control was extended to the docks and steamers of the South-Eastern and Chatham and the Brighton Companies. He will be succeeded therein by his assistant, Mr. G. R. Newcombe.

IN the official announcement issued by the Southern Railway as to the re-arrangement of the roads and connections in Cannon-street Yard a phrase was used which is liable to misinterpretation. It was said that the new junction would be laid down on some waste land at New Cross and "subjected to every kind of test until there is no possibility of a mistake being made." In so laying out the new junctions the Southern Railway engineers are only following their own and all other engineers' practice for very many years. No complicated crossing or junction, even if only affecting two lines, is put in nowadays without a plan being prepared on a scale of 8ft. or 10ft. to the inch, and on the material to that plan being got together the whole is constructed by the side of the line It is the crossings that cause the greatest difficulty, and every component part—wing rails, point rails, check rails, crossing No. 1, No. 2 and No. 3 chairs, crossing check chairs, common chairs, distance pieces, &c.—is laid in and made to fit correctly, together with the fish-plates, fish bolts and every other detail. All points have their fittings put in position and the correct movement ensured. Points that require facing point lock equipment are furnished with it, and if there is to be a locking bar the rails are drilled for the clips that carry the bar. When the connections are complete and have been approved, the various parts receive indication marks, and the whole is then dismantled, and when the determined day arrives, the old work is ripped out and the new quickly slipped in.

Notes and Memoranda.

IN connection with the design of the new bridge over the Hudson at Castleton, New York, the *Canadian Engineer* points out that it is an example of the fact that the European idea of rigid riveted joints is gradually displacing the American idea of pin connections, except in extremely long spans.

THE Administrative Board of the American Engineering Council is of the opinion that "the mechanical power used on farms is a comparatively small item in the nation's power demand, and that no practicable method has yet been devised for supplying such power (electrically) on any basis that the average farmer could afford to pay."

IN connection with a boiler explosion on a small steamer recently reported on, the Engineer Surveyor-in-Chief, Board of Trade, remarks that the practice of substituting bolts to replace rivets in boiler work should only be regarded as a temporary expedient, as sooner or later leakage usually occurs at such parts, and rapid local wasting follows.

SOME efforts are being made to utilise underground water, pumped from a depth of about 150ft., for grazing purposes in the arid country north of Broken Hill, Australia; but the strange feature of this country is that fresh water is met with in one bore and perhaps 20ft. away salt water unfit for human consumption also comes in rising to the same height.

SOME heavy cast iron fly-wheels at Blackpool Tower were recently cut up for dismantling by means of the acetylene blow pipe. The section cut through was 10½in. by 22in., which, according to *Industrial Gases*, is a record for cast iron. The first cut was completed in 40 min., with an expenditure of 540 cubic feet of oxygen and 80 cubic feet of acetylene.

A SCHEME to supplement the water supply of Sydney New South Wales, from the Grose River, by the construction of a dam at the junction of Wentworth or Barton's Creek with the Grose, was outlined by Mr. T. W. Keele recently. He estimates that the supply would be increased by 47 million gallons of water a day. The cost of the scheme he estimates at £2,529,000.

IT has been decided, in connection with the Cauvery Dam, near Seringapatam, India, that provision for a maximum flood discharge of 35,000 cubic feet per second is suitable and sufficient; that the dam masonry should be raised to 130ft., as proposed by the special officer, and only works relating to automatic shutters, parapet wall and compensation for land above 106ft. may be postponed, that the profile of the dam has ample strength to store water up to 124ft. above bed, and that the revised estimates, providing for all works necessary to complete the masonry up to 130ft. level, is in order and may be sanctioned.

AN unusual form of boiler accident is described in one of the latest official reports. It happened on a Tyneside dredger, and resulted in a man being badly scalded. The boiler, of the vertical type, was fitted with an ordinary blow-down cock, but the pipe on the discharge side of the cock could not be left permanently in position. When it was desired to blow down the boiler the pipe was temporarily screwed into the cock flange. On the occasion under review the pipe was torn out of the fitting, during blowing down, and the uncontrolled water scalded the attendant. It is recommended that the pipe should be fitted with a permanently attached flange.

IN the course of a lecture on motor fuels, Professor J. S. S. Brame said that the most promising source of cheap raw material lay in the prolific tropical vegetation, but the problem was to release the fuel in a form suitable for use in internal combustion engines by a simple and economical process. No such process had so far been devised, but, even if it were, there were many subsidiary problems. For a number of years to come, it did not appear possible to produce alcohol as a fuel at such a price that it could replace even an appreciable fraction of the petroleum product. But it had an undoubted future, and would come into its own only when petrol and benzol were becoming exhausted.

A NEW scheme of funnel markings of destroyer flotillas is announced by the Admiralty for the re-numbering of certain of these flotillas from April 1st last. Foremost funnel leaders in the Mediterranean and Atlantic Fleets will be marked with a 4ft. black band round the top. Divisional commanders will have a 2ft. band 3ft. from the top of the foremost funnel—white for Atlantic Fleet vessels and black for those in the Mediterranean. The after funnel in all vessels will be marked with bands as follows :—In the Mediterranean Fleet the First, Second, and Third Flotillas will have one, two and three black bands respectively, and the Fourth Flotilla will have no mark. In the Atlantic Fleet, the Fifth, Sixth, and Seventh Flotillas will have one, two and three white bands respectively; the Eighth Flotilla, manned by two-fifths' complement, will have one black (upper) and one white; and the Ninth Flotilla, in reserve, will have two black (upper) and one white band.

A DEVICE for indicating the load carried by a transformer, while in operation, has been developed by the General Electric Company of America. If a transformer becomes overloaded, a semaphore is tripped and is swung into view. The attention of the staff is thus called to the condition. The need for such an instrument, it is claimed, has long been felt by the distribution engineer. According to the *Electrician*, the device consists fundamentally of two thermometers connected in series. The first indicates the temperature of the oil at the top of the transformer tank, and the second the external temperature. The two readings added together are shown on a dial, and are a measure of the load which the transformer is carrying. Readings in excess of 100 deg. Cent. show that the transformer is too small, since it has carried a continuous load or a short time overload sufficient to bring the temperature of the internal windings to 100 deg. Cent. or higher. The device is easily fitted by lifting the cover from the transformer and slipping over the edge of the tank the arm which supports the indicating dial on the outside of the tank. Readings can then be made from the ground.

Miscellanea.

IT is hoped that about 600,000 tons of coal will be shipped from Spitzbergen this season.

COAL has been discovered at Firbeck Main Colliery at Langold, near Worksop (Notts.), at a depth of 800ft.

TENDERS will be invited very shortly by the Egyptian State Railways for a number of steel coaches and for the erection of a bridge at Dessouk.

THE 80-ton floating crane required by the Lyttleton, New Zealand, Harbour Board is to be built by Sir Wm. Arrol and Fleming and Ferguson.

THE construction of the Welland Ship Canal in Canada is, according to Mr. C. H. Mitchell, the largest piece of engineering work going on in the world to-day.

WORK is now proceeding night and day on the construction of the new Canadian Pacific pier at Vancouver, and it is expected that the project will be finally completed by the autumn.

IT is hoped that the 1150ft. graving dock, which is being built at Esquimault, Vancouver Island, will be completed this summer, while the 550ft. floating dock should be finished very shortly.

THE new bridge over the river Derwent, at Baslow, Derbyshire, was opened yesterday, the 14th inst. It is 40ft. wide and replaces the old bridge, which was only 14ft. 3in. wide and had gradients of 1 in 10.

THE fast motor boat races organised by the Motor Boat Clubs' Joint Racing Committee are to be held on the Thames, between Putney and Kew, on Saturday, June 6th, and Thursday and Friday, June 18th and 19th.

A THIRD automatic rotary converter sub-station has been completed and put into commission in Durban. It is in an existing rotary sub-station building in Cato-street, in the "Cato's Creek" area near the foot of the bay.

WATER from the upper San Joaquin River was turned into the 13½-mile Florence Lake Tunnel under Kaiser Range, Fresno County, California, on April 13th. The tunnel is to divert the river into Hardington Lake, the reservoir at the head of the Big Creek-San Joaquin system of the Southern California Edison Company.

THE Doncaster Corporation proposes to expend some £500,000 for the following purposes :—Gas undertaking, £10,000; water, £32,930; electricity, £55,191; light railway, £10,350; motor omnibus, £13,400; street improvement, £37,499; works of sewerage and sewage disposal, £129,600; erection of dwellings for working classes, £228,068.

THE New Zealand Public Works Department is contemplating several additional irrigation schemes in the Otaga province. One of these is an extension of the Teviot scheme that gives water for power purposes, the water being afterwards taken for irrigation. The other projected undertaking is at the Manaherikia Falls, which entails the construction of a dam with a concrete wall 200ft. high for irrigation purposes.

THE water power plant at Elko, British Columbia, which is capable of generating 15,000 horse-power at 6600 volts, using water under a 192ft. head from Elk River, has been completed. The plant makes use of a 1200ft. wood stave pipe, 12ft. in diameter, and will bring the company's generating capacity up to 22,200 horse-power. A new aluminium transmission line, 100 miles in length, a duplication of the present line, has also been completed.

THE American Bureau of Standards has published a revision of the 1921 progress report of the National Screw Thread Commission. The more important changes made in the specifications include, among others :—The classes of fit have been renamed and renumbered; the tolerance on major diameter of screws of Classes 3, medium fit, and 4, close fit, have been made the same as for Class 2, free fit; specifications for gauges have been extensively revised. Generally speaking, any screw thread product which met the previous specifications will meet the revised specifications.

As now conceived, the Grand Falls project in New Brunswick will have an ultimate capacity of upwards of 70,000 horse-power, subject only to the limitation imposed by access to possible storage reservoirs in the upper reaches of the St. John. It is, of course, unnecessary to make expenditures during the initial stages of development for completion of all the works which will ultimately be required. In consequence, the works to be undertaken at the start will only be such as may be required in order to produce an installed capacity of 50,000 horse-power in two units of 25,000 horse-power each.

AMONG the guarantees which the Treasury has agreed to make under the Trade Facilities Act there are :—£2,000,000 for Synthetic Ammonia and Nitrates, Ltd.; £500,000 for the North British Aluminium Company, additional to the £2,000,000 already guaranteed; £400,000 for the Soudan Light and Power Company; £200,000 for the Londonderry Corporation, for waterworks; £280,000 for the Anglo-Scottish Beet Sugar Corporation; £100,000 for the Dunstable Portland Cement Company; and £300,000 for the Toho Electric Power Company, for the purchase of materials and machinery in Great Britain for the extension of electrical plant in Japan.

IN order to improve the entrance to Durban Harbour the consulting engineers recommend the immediate extension of the South Breakwater by 300ft., the removal of not less than 300ft. of the "cant" of the North Pier, and the clearance from the channel of the remaining concrete blocks, with an ultimate extension of the breakwater by from 600ft. to 800ft., the removal of the whole 600ft. of the North Pier cant, and the construction of a new North Pier on the site of the old Veitch's Pier, as a solid block curving towards the extended head of the South Breakwater, and ending opposite it. This would then permit of the removal of the whole of the present North Pier, and, when a quantity of rock and soil has been removed from the base of the breakwater, would provide a channel with a bottom width of 600ft. and a minimum depth of 36ft. at low water ordinary spring tide.

RECONSTRUCTION OF THE BOW STATION OF THE CHARING CROSS ELECTRIC SUPPLY COMPANY

MR. J. S. HIGHFIELD, M. Inst. C.E., LONDON, ENGINEER

(*For description see page 542*)

FIG. 6—THE BOILER HOUSE

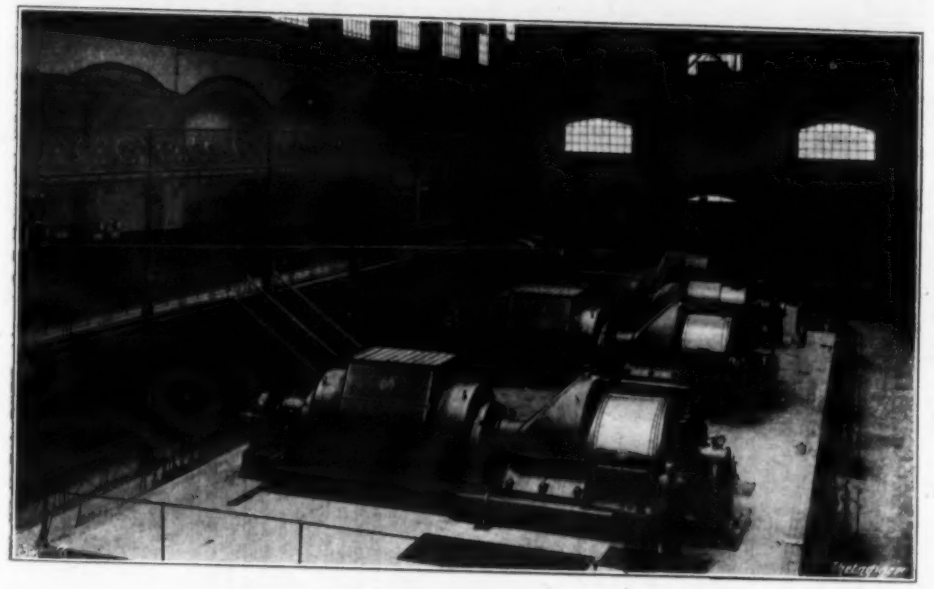


FIG. 7—THE GENERATOR HOUSE

FIG. 8—CIRCULATING WATER STRAINERS

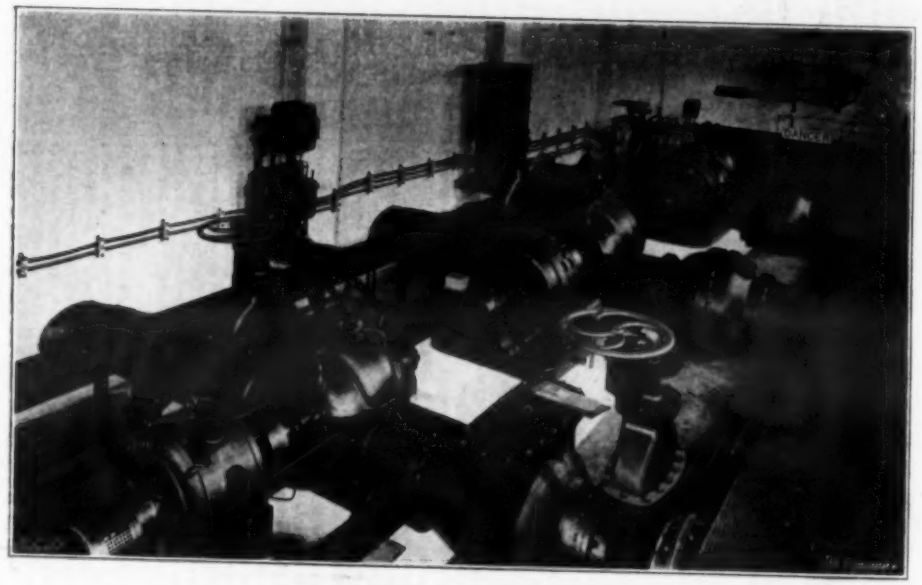


FIG. 9—CIRCULATING WATER PUMP HOUSE

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.

CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.

EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.

FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris. CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.

BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

INDIA.—A. I. COMBRIDGE AND Co., Bombay; THACKER AND Co., Limited, Bombay; THACKER, SPINK AND Co., Calcutta.

ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umbarto 1, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.

JAPAN.—MARUZEN Co., Tokyo and Yokohama.

AFRICA.—WM. DAWSON AND SONS, Limited, 7, Sea-street (Box 49), Capetown.
C. JUTA AND Co., Johannesburg, East London, and Grahamstown.

AUSTRALIA.—GORDON AND GOTCH, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
MELVILLE AND MULLEN, Melbourne.
ATKINSON AND Co., Gresham-street, Adelaide.

CANADA.—DAWSON, WM., AND SONS, Limited, 87, Queen-street East, Toronto.
GORDON AND GOTCH, Limited, 132, Bay-street, Toronto.
MONTREAL NEWS Co., 386–388, St. James-street, Montreal.
TORONTO NEWS Co., 42, Yonge-street, Toronto.

CEYLON.—WIJAYARTNA AND Co., Colombo.

JAMAICA.—EDUCATIONAL SUPPLY Co., Kingston.

NEW ZEALAND.—GORDON AND GOTCH, Limited, Wellington and Christchurch; UPTON AND Co., Auckland; J. WILSON CRAIG AND Co., Napier.

STRAITS SETTLEMENTS.—KELLY AND WALSH, Limited, Singapore.

UNITED STATES OF AMERICA.—INTERNATIONAL NEWS Co., 83 and 85, Duane-street, New York; SUBSCRIPTION NEWS Co., Chicago.

SUBSCRIPTIONS.

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DEATH.

APRIL 27th, Geo. W. King, founder and managing director of Geo. W. King, Ltd., Windmill-lane, Stratford, London, E. 15.

THE ENGINEER.

MAY 15, 1925.

Naval Shipbuilding Requirements.

ALL who appreciate the importance of naval defence will welcome the new shipbuilding programme which the Government is expected to introduce before Parliament adjourns for the summer recess. We have put off till the very last moment the provision of new ships to replace those which are past their prime, and the result is that our present-day Fleet, though sufficiently imposing on paper, contains a large proportion of second-rate vessels, deficient in speed, armament, and other essential qualities. Particularly is this the case with our cruisers, of which no more than a dozen compare at all favourably with representative ships under foreign flags. The hope that other Powers, noticing the virtual suspension of naval shipbuilding by this country, would refrain from expanding their respective fleets, has not been fulfilled. While it might be premature to speak of a new race for naval supremacy, there is an unmistakable tendency abroad to multiply vessels of which the aggregate tonnage is not restricted by the Washington Treaty. Cruisers, destroyers, submarines—all may be built without limit as to number, and since the relative combatant worth of such craft has been substantially increased by the reduction of battle fleets, a certain temptation exists to develop these types on a liberal scale. Hence the large programmes of so-called "auxiliary" construction which have come into effect since the Washington Conference. Taking cruisers alone, it will be found that the five leading Powers have legislated since that event for a total of 40 new cruisers, and of this number only seven are being built for the British Empire. In destroyers and submarines the British ratio of new tonnage is very much lower. Having regard to the magnitude of our sea interests, it is clearly impossible for us to remain passive in the face of this progressive decline in our naval power. Imperative as the demand may be for economy in State expenditure, it must not be allowed to override the urgent needs of national defence. In the case of the Navy retrenchment has already been carried to the extreme limit. From now on it will pay us better to invest money in new ships than to spend it on the upkeep of material which is largely inefficient.

A study of the Navy List shows that about a score of the cruisers retained for service has ceased to be effective for war purposes. Probably these vessels would have been paid off long since, but for the shortage of cruising ships of any description. As it is, they must continue to serve until replaced by something better, but the expenditure of large sums year by year on ships of inferior fighting value is bad policy from every point of view. Thanks to the patriotic action of the Australian Government in ordering two ships, seven major cruisers of post-war design will eventually be at the disposal of the Empire. These, however, can be regarded only as the nucleus of our future cruising fleet, which the Admiralty considers should attain a strength of 52 units. This estimate may be revised by the Government committee which has been investigating the whole question of ship replacement, though in our judgment it errs, if at all, on the moderate side. Whether all the new cruisers should be of the 10,000-ton type which the Washington agreement has practically standardised is a problem of some importance. While it is true that most of the foreign vessels now under construction belong to this class, both Japan and France have built ships of considerably smaller dimensions. Cruisers of 10,000 tons seem to us unnecessarily large for duty with the Battle Fleet, for which function ships of reduced displacement would probably be of equal use and much less expensive. It is to be hoped, therefore, that our constructors will not acquire the habit of regarding the maximum tonnage allowed by the Treaty as the basic figure for all new cruiser designs. For reasons which may be cogent enough—though they are not very obvious to the uninitiated—the Admiralty chooses to observe a great deal of mystery about the ships now in hand. We can only trust that this policy of reticence will be justified by results, but past experience with ships built in a similar atmosphere of secrecy has not been encouraging. The three French cruisers of the "Duguay-Trouin" class, although laid down after the Treaty, have a normal displacement of only 7900 tons. High speed is their main feature, to achieve which both armament and protection have been sacrificed. Their speed is 34.5 knots, they mount eight 6.1in. guns, and armour is non-existent save for thin decks and splinter-proof gun turrets. Acclaimed at the date of inception as wholly admirable, the design has since been condemned by some of the foremost French critics. Of greater interest are the four Japanese cruisers of the "Furutaka" class, the nameship of which was put afloat in February and the Kako last month. Displacing only 7100 tons, they have a legend speed of 33 knots, and are armed with six 8in. guns, so disposed as to permit of a full discharge on either beam and a bow fire of four guns. In planning these ships Japanese designers seem to have moved out of the rut in which some of their foreign colleagues are apparently content to remain. There is not, nor has there ever been, any technical objection to arming a ship of moderate size with a few heavy guns, instead of a greater number of lighter pieces. Volume of fire was, no doubt, the cardinal factor in former years, when control methods were of the crudest, and a ship of fine lines, apt to be lively in a seaway, could not hope to make effective use of slow-firing ordnance of heavy calibre. But to-day, when the gun of medium calibre can be worked as easily, and discharged almost as rapidly, as the quick-firer of an earlier period, and when, moreover, improved systems of fire-control ensure a reasonable percentage of hits under difficult conditions, the cast iron rule of equipping light cruisers with no guns above 6in. calibre is, or ought to be, discredited. By disregarding this obsolete rule Japanese designers have evolved in the Furutaka a ship of considerably greater fighting power than contemporary vessels of equal and even superior tonnage. Compared with her, the 7500-ton American cruisers of the "Omaha" group, with their twelve 6in. guns, appear to disadvantage, and our own ships of the "E" class—7600 tons and seven 6in. guns—are still worse. Unless the experience derived from the late war is utterly misleading, neither the Omaha nor the Enterprise would stand a sporting chance in a duel with the smaller Japanese ship. We cite the Furutaka merely as a specimen of what may be done on a much smaller displacement than 10,000 tons, without suggesting that replicas of the design should be laid down for the British Fleet; though it does seem to us that ships of this class would be more useful than vessels like the Enterprise and Emerald. The only British cruising ship that approximates to the Furutaka in size is the Adventure, which is primarily designed for minelaying. Her dispacement is 7260 tons, but although she was launched nearly a year ago, details of her speed and armament are still withheld by the naval authorities.

In addition to cruisers, the forthcoming programme is expected to make provision for destroyers and submarines. Of the first-named we have 195

boats. Half of them were built during the war, and their normal span of "life" has been curtailed by the strenuous service they were called upon to perform. Actually, therefore, we have only about 100 destroyers that are thoroughly efficient. The design of future boats must perforce be influenced by current progress abroad, which is all in the direction of increased tonnage and heavier armament. The new French flotilla leaders, of which 21 are under construction and projected, are vessels of 2360 tons, with a speed of 35.5 knots, armed with five 5.1in. guns. There are no leaders as powerful as this in our service. Japan, also, is reported to be planning a series of new "destroyers," to displace no less than 3000 tons and to carry several 5.5in. guns. The value of the destroyer as an antidote to the submarine was so clearly demonstrated in the late conflict that the need for maintaining an adequate force of vessels of that type scarcely requires emphasis. It is true that the Washington agreement seeks to ban submarine attacks on merchant shipping, but one of the leading Powers has still to ratify this particular clause of the Treaty, and parchment safeguards are not, in any case, always effective in time of war. Finally, we have fewer submarines than either the United States or Japan, though the type is one clearly destined to play an important part in naval strategy. A strong case could be presented for laying down a dozen or more new submarines of large dimensions, to be employed as patrol ships or convoy guards, on the oceanic trade routes which form the arteries of the Empire. Apart from the obsolete "K" class, we have at present only five or six submarines capable of undertaking this essential duty. There will, no doubt, be an outcry in some quarters when the new shipbuilding programme appears, for the cost is bound to be heavy. But the bill must be faced unless the country is prepared to sacrifice its sea power, which is synonymous with its safety, welfare, and prosperity.

The Government Inspection of New Railways.

DURING the first thirty or forty years of British railways there were many inquiries by Royal Commissions and Select Committees into questions of administration. A remarkable feature of these investigations was the unanimity displayed in the recommendation that Government should not interfere with the conduct of the railways. One such conclusion to which, on the present occasion, we would specifically refer was that of a Select Committee appointed on March 9th, 1841, to "consider whether it is desirable for the public safety to vest a discretionary power of issuing regulations for the prevention of accidents on railways." That Committee reported that instead of a supervision by positive regulation, one by suggestion should be adopted. The Bill which became the Act of 1842 was the result and Gladstone, in introducing it, said that the Board of Trade wanted power to postpone the opening of railways when that course was deemed desirable. The wording adopted in the Act was virtually to the effect that if the inspecting officer considered that the use of a railway would be attended with danger to the public, by reason of the incompleteness of the works and permanent way or the insufficiency of the establishment, the Board of Trade could order the postponement of the opening. Such postponements later became so frequent and often so annoying that in 1859 the Board of Trade issued a list of the main requirements that the inspecting officers considered necessary, in order that engineers could execute their works accordingly. That was the first issue of what became known as the Board of Trade Requirements for New Railways, and the last was issued in 1914. One of the many tasks with which the Ministry of Transport signalised its establishment in 1919 was a revision of these Requirements, but instead of the work being done by the inspecting officers alone, as with previous revisions, those officers were assisted by eight railway representatives—two civil engineers, two mechanical engineers, two operating officers, one signal engineer, and one telegraph superintendent. The new regulations, as related on page 265 of our issue of March 6th, came into force in February last and attract attention at the moment because they formed the subject of a most interesting paper by Colonel Sir John Pringle, the Chief Inspecting Officer of Railways, read at the London Congress of the Institute of Transport on Wednesday last, May 13th.

Sir John Pringle's paper shows clearly how the Government has gradually assumed more and more control over the means and methods employed in the construction and operation of our railways. The haste with which railways were built and opened eighty years ago may have justified Government inspection in the interests of the public, and the lack of knowledge among engineers as to what was needed to secure safety may have warranted the issue twenty years later of a list of what the inspecting officers considered essential. In contrast to our railway accident record of to-day that of the 'seventies and early 'eighties appears very bad, but it is significant that, beyond a requirement in 1868 to provide communication between passengers and trainmen, the Government neither secured nor sought any restrictive legislation until the Act of 1889, which made compulsory the block system, the concentration and interlocking of points and signals, and the provision of automatic continuous brakes for passenger trains. It must be admitted that the companies had been slow in appreciating the value of such safeguards, but nevertheless they were almost universal by 1889, and the main purpose of the Act lay, not so much in the mandatory clauses, as in Sec. 3, which allowed the Board of Trade to grant certificates permitting debenture stock to be issued to meet the expenditure under the Act. Whilst there was some measure of justification for Government control in those days, it is questionable if it still exists. Our railways have been brought to a very high standard, and there would seem to be now no good reason why the responsibility for saying what shall and what shall not be done should be assumed by the Government. Such action is a form of Government control, and therefore a step towards State administration. It was possibly desirable to revise the Requirements of 1914, but in accepting that revision the railways have, it must be admitted, parted with some of their liberties. The necessity for the Ministry to give a ruling on certain points would exist were the companies unaffected by the accidents that occur, indifferent as to their responsibilities, or unable to agree among themselves or among their respective officers as to what was essential. Not only is such not the case, but the grouping of the railways has, in itself, so standardised engineering and signalling methods that the "greater degree of standardisation of railway practice" Sir John Pringle referred to has come automatically. The initiative has been allowed to pass from the companies to the Ministry, and the former can now no longer start on any new work until the plans of the stations and diagrams of the signalling have been approved. True, it is not imperative that the plans shall be laid before the Ministry, but it is laid down that they shall be submitted wherever possible. The necessity for the Ministry's approval would, again, be warranted did the inspecting officers originate improvements. They do not do so. It is the companies' officers who see the necessity for a change, who make the necessary experiments and then take the responsibility for their adoption. Not until they are successful on one or more lines do the inspecting officers ask for them. Furthermore, many reforms have been effected in recent years which would not have seen the light of day had the signal engineer had first to put them on to a plan and then achieve the very difficult task of getting his chief engineer and general manager to approve them for submission to the Ministry. Lastly, there is the fact that the inspecting officers have not always been in accord. Sir John Pringle, for instance, concludes his paper by expressing the hope that the prospects for automatic train control will in the near future be more favourable than they are at present. Yet his predecessor, Sir Arthur Yorke, practically condemned such an idea in his report on the Slough accident of June, 1900. For a score or so of years the inspecting officers neglected no opportunity to recommend lock-and-block, but in four or five of his reports Sir John has pointed out the weaknesses of that system. Facing safety points in bay sidings and in passenger loops have hitherto been forbidden, but now they are, under the new Requirements, made necessary in certain cases.

Fortunately, the administration of the Requirements is in the hands of very capable, broad-minded men, and as long as it so remains no serious harm can result. The last two generations of inspecting officers, from Sir Francis Marindin onwards, have been exceedingly fair. Often, when an inspection has been made, the Government inspector has turned to the signal engineer and observed that such and such a thing had not been done. The reply would be, "No, Sir; that is not our practice." That answer was enough. Certain companies went further than others, but if what the latter did satisfied the essentials of safety it was considered sufficient. It has been the same in accident inquiries. Whenever a man has been at fault, but the company's methods contributed to the error, the officers were made to share the blame. In that respect a powerful company was criticised just as severely as a smaller; the inspecting officers have never been respecters of persons. The same fairness characterises these new Requirements. They open with the observation that they may be relaxed to meet individual cases and that, in order to secure economy with due regard to safety, they may be modified at the instance of the Minister of Transport, having regard to such special circumstances as may be submitted for consideration in each case. The work, we admit, has been exceedingly well done. As we have shown, the administration of the Act has been wisely conducted, but it is amongst the factors that have made our railways the most costly in the world, and one may express the hope that the Ministry will generously exercise the power that is given to it to relax its requirements and that at no time too officious officers will insist on requirements which may hamper the development of railways and augment their cost.

Internal Stresses.

CALCULATIONS for structural or mechanical design are rightly based on the assumption that the materials employed in actual construction will not fall short in regard to strength, of their specified or tested values. Such variations as cannot be avoided are covered by the factor of safety, which is intended to allow for these and other incalculable contingencies. There is, however, a further implied assumption, whose importance is not so widely recognised as is desirable, and that is that the materials employed, when the machine or structure is finished, shall be free from serious initial, or, as it is more frequently called, "internal" stress. It is true that where materials are employed in a thoroughly soft condition, such as annealed steel brass or copper, and the construction is of a simple straightforward kind, initial stress may be entirely or almost entirely absent, but types of construction to which such a description is strictly applicable are rare, and the increasing demand for higher efficiency in engineering products tends to eliminate them. Harder materials, often in a heat-treated or cold-worked condition, are required to meet the calculated stress requirements. Complexities of design and construction become unavoidable, and a serious element of uncertainty in regard to initial stress is introduced. The demand for lightness and the ability to withstand increasingly severe working conditions implies a tendency towards heavier working stresses, so that there is a steadily increasing need to take account of initial stresses and to study and investigate the whole question.

Initial stresses may originate in two entirely distinct ways. First, they may arise in the manufacture of the material itself, quite apart from anything that may be done to it in the course of construction. The severe internal stresses sometimes found in cold-drawn or cold-rolled metal are examples of this type. The softer metals lend themselves readily to shaping in the cold, and the process is undeniably attractive, both on account of its cheapness and convenience and because it yields an apparently highly satisfactory product, clean of surface and sharp and accurate of outline. Nor is it suggested that all cold-working processes necessarily involve the production of serious internal stress. Provided that the deformation of the metal is carried out in such a way as to bring about a reasonably uniform distribution of plastic deformation throughout the mass of metal, no severe internal stresses need remain at the end of the operation. On the other hand, it is not always easy to satisfy this condition, even approximately, and in extreme cases the cold-worked material may be initially self-stressed almost to the breaking point. Severe cold-working of the surface layers of a piece of metal, while the interior is left but slightly affected, is a frequent cause of such stresses; the spontaneous cracking of some types of drawn tubing and rod is a result of the severe stresses thus set up. Extreme cases of this kind are, fortunately, rare, but an initial stress on part of a piece of metal amounting to one-half or even one-third of its normal strength is of much more frequent occurrence, and is, in some ways, more serious, since it is not readily detected, and may yet prove dangerous when a working stress is added in service. Yet few, if any, of our engineering specifications provide any kind of test to show that the material is free from initial stresses of this kind. Recent research has shown that, fortunately, serious initial stress can often be removed by a simple form of low-temperature heat treatment, and such treat-

ment is, we believe, in use for certain types of drawn brass tubes. We doubt, however, whether its possibilities for other cold-worked metals are as yet widely known or appreciated. Initially or self-stressed materials are not, however, confined to those produced by cold working. When steel is subjected to any kind of hardening process, volume changes occur which, if they are not perfectly uniformly distributed, also lead to the presence of severe internal stresses. Failures under such stress, known as hardening cracks, are all too well known, but severe stress not far removed from the breaking point may exist undiscovered in many other cases. Fully hardened steel is not, of course, employed to any serious extent for engineering purposes, some degree of subsequent drawing or tempering being nearly always applied. In many cases it is probable that the main advantage of the tempering lies in a more or less complete removal of these internal stresses. Often, however, the application of a tempering heat is followed by rapid cooling; in some steels, subject to what is known as "temper brittleness," such rapid cooling is essential, and there again a certain degree of internal stress is likely to be set up. A much more serious cause of trouble, however, arises where portions of a heat-treated piece are further heated, during construction for instance, in such a way as to bring about local softening. The effect depends on the size and shape of the parts affected, but in certain conditions, serious self-stressing may result.

Were these the only causes of initial stress, engineers might well turn to the metallurgists to provide them with materials free from so serious a defect. Unfortunately, the causes of initial stress in a finished structure lie, at least as frequently, at the door of the constructor. The need for ductility in structural materials is often insisted upon as being essential in view of the unavoidable inaccuracies of workmanship, so that the material may adjust itself, by a little local yielding, until the working stresses become uniformly distributed. Where errors of workmanship are really unavoidable, and therefore quite small, this theory appears to be sound enough. But in actual practice—bad practice, it is true, but common enough—the ductility of the metal is often relied upon to allow of accommodation to comparatively large errors of fitting. We have heard of such things as drifted rivet holes, and boiler and ship plates have been known to be stretched a little to make them fit into place! While recognised as bad practice, the serious danger of such treatment is not, perhaps, fully appreciated. It does not lie in the fact that the metal has been locally somewhat hardened and deprived of some of its ductility, but in the serious initial stresses which are thereby "built into" the structure. In more than one instance, such local self-stressing has been enough to cause local cracking and ultimate failure, although the material as a whole was of excellent quality and the design perfectly sound. There are, too, other less obvious causes of initial stress. Heavy riveting pressures, excessive tightening of stay bolts, the forcing into place of redundant structural members, may all lead to internal stress out of all proportion—particularly when localised—to the causes producing it. Care in design and still greater care in the supervision of erection methods can do much to eliminate these evils, but the fact that they may exist and that they form potential sources of danger is one that requires full recognition by engineers and metallurgists alike.

Obituary.

ALFRED ERNEST WELLS.

WE regret to have to put on record the death of Mr. Alfred Ernest Wells, the deputy-chairman of Edgar Allen and Co., Ltd.

Mr. Wells, who was born in 1857 at Eckington, in Derbyshire, was a son of the late George Wells, of J. and G. Wells, Ltd., colliery proprietors. He was educated at the Bradford Academy, and in October, 1874, went to Samuel Osborn and Co., Ltd., where he acquired an excellent commercial and works training. By the year 1880 he was doing most of the buying for that firm, and had also direct charge of the steel foundry, and continued to carry on that work until March, 1890, when he joined the late William Edgar Allen and the present chairman, Mr. Robert Woodward, in founding the firm of Edgar Allen and Co., Ltd. In those days the foundry, which was always Mr. Wells's special care, was a very small department, and the steel was made in a gas crucible furnace. During the summer of 1890 Mr. Wells was on the Continent investigating the Robert process of steel making, and although he decided that, in its then form, it was unsuitable, he quickly saw that if certain modifications could be introduced the process had possibilities.

In connection with his researches he met the late Monsieur Tropenas, and a personal friendship was formed which only ended with that gentleman's death in 1917. The result of the co-operation between Mr. Wells and Monsieur Tropenas was the now world-famed process which bears the latter's name. The first converter was installed in the Edgar Allen foundry in 1891. It proved to be one of the best innovations undertaken by the firm, and Mr. Wells threw all his energy and enthusiasm into it, making it a great success. Always a hard worker, keen on detail and method, and quick to recognise a good thing when he saw it, he made the Tropenas process, combined with his great knowledge of steel foundry work, one of the foundations on which the success of the firm has been built.

We have received, and have pleasure in publishing the following appreciation of his career:—"There was no better-known figure in the whole Edgar Allen works than Mr. A. E. Wells, although in his latter days he did not move at the pace which earlier on in his career earned him a notorious sobriquet. The development of the Edgar Allen foundry was undoubtedly due to the energy and ability of Mr. Wells, and although much of his time was in later life taken up by the larger questions of commerce and finance, he always made a point of keeping closely in touch with everything that went on in the foundry department.

"The secrets of Mr. Wells's success were first, his thoroughness in anything he had in hand; and, secondly, his remarkable memory. He could give minute and exact particulars of incidents or transactions even after the lapse of many years. He was a good talker, full of anecdote, and one of the cheeriest companions when on a journey.

"He never had much taste or time for public life, although for six years in succession he was president of the Rotherham Chamber of Commerce—probably a record for the country. He was always an insatiable worker, and during the war was so keen to do everything possible to beat the Germans, that he became chairman of the Board of Management of a Shell Factory at Rotherham, which, at the close of hostilities was turning out 5000 4.5 shells per week, and had an aggregate turnout of about 450,000. The fine results obtained at that factory were due in no small degree to Mr. Wells's intimate knowledge of human nature.

"In March, 1919, Mr. Wells, then in his sixty-second year, was knocked down by a motor lorry travelling at over 30 miles an hour. That he survived at all was due solely to a magnificent constitution, and to a lifetime so full of hard work that he had no time to spare for anything else but healthy exercise. Although he made an almost complete recovery, the accident must considerably have shortened his life.

"Those who did not know him well perhaps formed the opinion that he was stern and a martinet, but in reality he was one of the kindliest men living. He was appointed a Justice of the Peace for the County Borough of Rotherham in 1919, and in that capacity did not hesitate to deal severely with those offences which were against the interests of the community at large; yet on the other hand, many a first offender or person brought before him who had been led astray, was put into the right direction by a few kindly words of counsel, and an indefinite remand for the purpose of trying again."

Literature.

Low Temperature Distillation. By SYDNEY H. NORTH and J. B. GARBE. London: Sir Isaac Pitman and Sons, Ltd. Price 15s. net.

WHILE most people are prepared to admit that our present methods of using and treating coal are wasteful, many will regard as overdrawn the assertion made by the authors of this book, that the waste is criminal. It is an exaggeration, we think, to say that the treatment of coal on an improved scientific basis is being sidetracked by mere prejudice and vested interests. It is premature to assert that the experimental period of low-temperature treatment is past, and that we now have sufficient experience to design and operate low-temperature distillation plants with both technical and commercial success. Great progress has undoubtedly been made, but as the reports of the Government Fuel Research Board reveal, neither technical nor commercial perfection has yet been achieved.

Nevertheless, the subject is one of the most pressing problems of the day, and as the success of any low-temperature process must ultimately rest with the consumers rather than with the chemists, engineers and owners of low-temperature plants, all steps should be taken to enlighten the public as to what low-temperature carbonisation is and what benefits, individual and national, we are likely to gain from its general adoption. Messrs. North and Garbe in this volume make an interesting and important contribution to that end.

The subject is of vital interest to the engineer from several standpoints. The construction of the actual distillation plant comes within his sphere, and to him will fall the task of adapting existing boiler and other equipment to take best advantage of the new coke-like fuel. He is, however, perhaps chiefly affected by the aspect of the subject affecting the world's supply of fuel oil and motor spirit. Vast as is the world's annual output of mineral oil to-day—it amounts, according to the authors, to some thousand million barrels—it is not sufficient to replace the coal mined in Great Britain alone. It is estimated that without interfering with the high-temperature processes employed at present at gasworks and coke ovens, there is available in this country for low-temperature distillation at least 150 million tons of coal per year. This coal would yield, it is calculated, 450 million gallons of motor spirit and 250 million gallons of crude oil, of which at least 50 per cent. would be high-class Diesel oil. With such an addition to our available oil supplies it may safely be said that all forms of power engineering would be radically affected.

By far the most important and extensive section of Messrs. North and Garbe's book is devoted to the description of modern low-temperature plant and the various processes followed by the different designers thereof. No fewer than 21 forms of low-temperature retort are described, with in some instances detailed data concerning the results obtained, and in most cases with sectional diagrams illustrating the design of the plant. Particular attention is paid to the Hartman, Parker, Maclaurin, Nielsen, Trent and Universal retorts. In earlier and succeeding chapters the authors discuss, among other matters, the general principles governing the carbonisation and distillation of coal, the work of the Fuel Research Board, the materials for low-temperature distillation available in Great Britain, briquetting of the coal agglomerate and the treatment of the residue remaining after distillation is completed. In three concluding chapters the low-temperature treatment of oil shale, lignite and peat is discussed and exemplified.

Having studied the various processes described by the authors, one is tempted to wonder whether the future lies with any of them rather than with some process for the direct conversion of coal into oil. Already, as the authors briefly indicate in an appendix, the hydrogenation of coal is, or so it is reported, being conducted in Germany on a commercial basis under the Bergius process. At present the procedure, involving the maintenance of hydrogen in contact with the coal for several hours at a pressure of some 3500 lb. per square inch and a temperature in excess of 400 deg. Cent., would appear to be of a dangerous nature. The operators, we are informed, are housed in dug-outs and the plant, erected within high thick walls, is manipulated electrically. It is reported that after the operation is completed as much as 75 per cent. of the gas, originally hydrogen, in the retort may be in the form of saturated hydro-carbons which, on cooling, yield a dark liquid, from which light hydrocarbons may be obtained by processes similar to those applied to natural crude oil. The necessity for the employment of a high pressure and temperature is obviously a serious bar to the exploitation of the process, but there seems every reason to believe that in the near future the position in this respect will be greatly improved by the discovery of a suitable catalytic material.

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Fifty Per Cent. Cut-off Locomotives.

PENNSYLVANIA RAILROAD SYSTEM.

By E. C. POULTNEY, O.B.E.

Part II.*

FROM the figures given in the preceding article it will be seen that the saving in steam per I.H.P. of the 50 per cent. cut-off engine is 38.7 per cent., and in the hourly evaporation 14.3 per cent., and from the comparative formulæ for W/C, fuel rates per I.H.P. hour are for the 2–10–0 2.8 lb. and 4.8 lb., equivalent to a saving of 4.42 per cent., whilst at the same time the engine develops 40 per cent. greater power, but in this connection it must not be forgotten that it was designed to have 25 per cent. greater capacity.

These figures, besides giving interesting information as to the conditions of steam consumption realised under different rates of speed and cut-off and the power available, bring into prominence two characteristics of outstanding importance. One is that the maximum possible water rate with the 50 per cent. cut-off is 19.5 per indicated horse-power, as against a possible 31.8 lb. for the ordinary engine; and the other is that *no matter how the locomotive is handled by the engineman, that consumption cannot be exceeded.*

Broadly, the results of test plant and road experience indicate that average savings of 20 per cent.

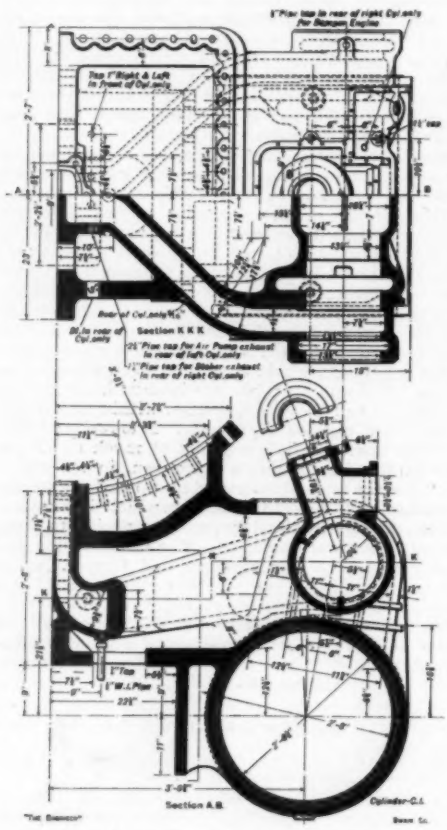


FIG. 7—CYLINDER AND VALVE CHEST

in slow-speed heavy service, 10 to 15 per cent. in fast goods, and about 10 per cent. for moderate loads and high speeds such as would obtain in fast passenger service, may be expected.

Whilst the information given by Fig. 5 *ante* indicates fully the relative steam rates at various powers and cut-offs, some particulars of the various results obtained during trials made on the testing plant may be given. They are briefly summarised as follows:—

Coal to Engines.—The rate of firing dry coal in pounds per hour chargeable to the engines varied from 2000 at 750 indicated horse-power to a maximum of nearly 12,000 at 3500 indicated horse-power, and the average coal rate per indicated horse-power per hour varied within the same power limits between 2.5 lb. and about 3.4 lb. Between 1000 and 2500 indicated horse-power the average coal rate was less than 2½ lb., and the minimum rate a fraction above 2 lb. at 1750 indicated horse-power. The calorific value of the fuels used was 13,429 and 13,420 B.Th.U. per pound, dry.

Steam Pressures and Temperatures.—The steam pressures maintained during the tests were uniform at 250 lb., the maximum pressure drop shown was 18 lb., and the maximum exhaust pressure 16.3 lb. The maximum superheat reached was 282.8 deg. Fah. at a rate of firing of 11,000 lb. per hour. Compared with the 2–8–2 locomotive, Class L 1 S, one of which has been tested, the temperature of the superheat obtained with the 2–10–0 locomotive was about 15 per cent. higher. On account of the larger number of elements the superheater of the 2–10–0 has 20 per cent. more surface. The normal saturated steam temperature for 250 lb. pressure is 406 deg., as against 389.5 deg. for the 2–8–2 using steam at 205 lb. per square inch.

Steam and Power.—The average steam rate, pounds of superheated steam per indicated horse-power hour, varied from about 21 lb. to slightly over 16 lb. between 750 and 3500 indicated horse-power, the rates quoted obtaining at the powers mentioned. At 2500 indicated horse-power the steam consumption was about 15.5 lb., the lowest shown, the corresponding coal being about 2.3 lb. Between the limits of about 1800 and 3200 indicated horse-power the steam rate was 16 lb. or less.

Engine Efficiency.—The thermal efficiency of the engines referred to the indicated horse-power above and calculated according to the A.S.M.E. method is at a minimum at 750 indicated horse-power, being then about 11 per cent.; at 2000 it is about 14.5, and between 2500 and 3500 it is just less than 15 per cent. The above figures are the mean results of the tests. The efficiency is taken as the ratio between the total heat used and that which is turned into work in the cylinders. The heat considered is that in the steam in the branch pipe above an ideal feed temperature which is assumed to be that of the steam in the exhaust.

Mechanical Efficiency.—It is difficult to make a general statement as to mechanical efficiency; so much depends on the conditions of speed and cut-off. The highest mean efficiencies seem to range from about 89 to about 85 per cent. at speeds of 40 and 140 revolutions, equivalent to 7.4 and 25.4 miles per hour respectively.

Thermal Efficiency of the Locomotive.—Here again considerable variations occurred dependent upon the test conditions. The highest average locomotive efficiencies attained run from about 7.8 to 6 per cent. at 40 and 140 revolutions, and between 60 revolutions (11 miles per hour) and 110 revolutions (20.4 miles per hour) the efficiency is rather greater than 8 per cent., being 8.1 at 80 revolutions (14.8 miles per hour). The highest locomotive efficiency given by the "Mikado" type engine was 7.0 per cent., so that on this basis the Decapod shows an improvement of 15 per cent. The Mikado developed 7.0 per cent. efficiency at 120, against 8.1 per cent. for the Decapod at 80 revolutions. The results above recorded were obtained during the hand-fired tests.

STOKER-FIRED TESTS.

At the conclusion of the hand-fired trials the locomotive No. 790 was equipped with a duplex mechanical stoker and returned to the testing plant for further trials. The fuel used was practically the same. The general results obtained with the stoker showed that hand firing is superior so far as the economical use of coal is concerned, the difference being most marked at low rates of combustion, and gradually diminishing as the rate of firing is increased. At about 180 lb. of coal per square foot of grate per hour the evaporation per pound of coal fired is equal for hand and stoker firing. This is at a firing rate of 12,600 lb. of coal per hour and much beyond the capacity of a fireman under average running conditions. At 40 lb. of coal per square foot per hour hand firing is 19 per cent. more economical than stoker firing. In view of the less water evaporated per pound of coal with the stoker, as would be expected, the coal rates per indicated horse-power are increased, and the test results show that the mean coal rates vary from between 3.25 lb. and 3.7 lb. at 750 and 3500 indicated horse-power. At 2000 indicated horse-power the coal per indicated horse-power hour is about 2.7 lb. and is 3 lb. or less between 1000 and 2500 indicated horse-power. The stoker is estimated to use about 2 per cent. of the steam generated.

Whilst it is true that the stoker is somewhat wasteful in the use of fuel, it is also true that without a stoker locomotives of the capacity of those under notice could not under service conditions be operated at more than 83 per cent. of their full power, taking the latter at 3000 indicated horse-power, and even then 6000 lb. of coal would have to be hand fired per hour when developing 2500 indicated horse-power. At this power the coal rates per indicated horse-power with and without the stoker are about 3.0 lb. and 2.4 lb., so that when fired by hand the consumption is 80 per cent. of that required when the stoker is used. Assuming that 6000 lb. per hour is the maximum possible for the quantity of fuel that can be hand fired in practice, and that 4000 lb. would be a more usual figure than under the latter conditions, then about 2000 indicated horse-power could be

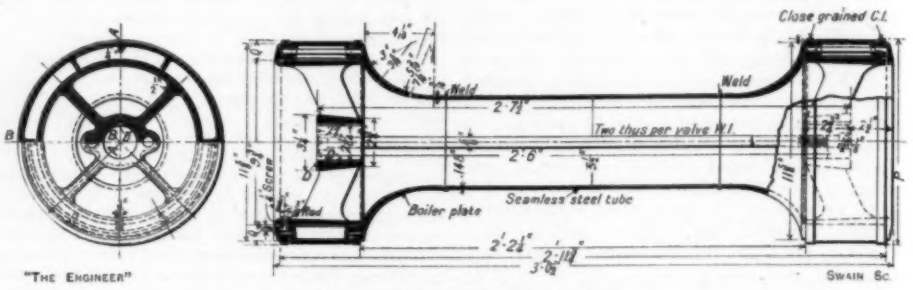


FIG. 8—LIGHT WEIGHT PISTON VALVE

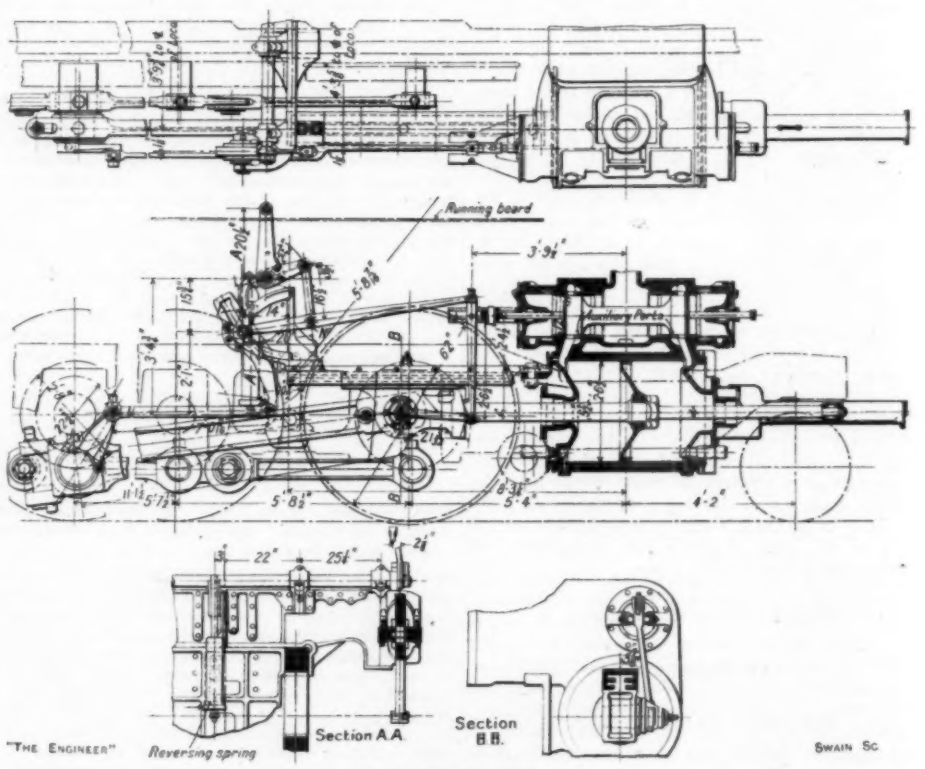


FIG. 9—VALVE GEAR

* No. I. appeared May 8th.

developed, or, say, 67 per cent. of the maximum of 3000 indicated horse-power. The above computations are based on the average coal fired chargeable to the engines, as shown by plotting the hourly amounts of coal fired against indicated horse-power.

In discussing the question of stoker firing the probability must be borne in mind that as less skill is required it is easier to obtain full efficiency with a stoker than with hand firing.

DECAPOD 2–10–0 TYPE LOCOMOTIVE. CLASS I. 1.s.

Generally, the Pennsylvania 2–10–0 locomotives do not differ from common practice on that line, and in the descriptive notes which follow, attention will therefore be mainly directed to those details of construction which are consequent to the adoption of the 50 per cent. cut-off system. From the list of dimensions already given it will be readily apparent that the outstanding features are the very large cylinders and the high boiler pressure.

So far as the cylinders and motion are concerned, it may be said that in general design they conform to usual Pennsylvania standards. Fig. 7 shows one of the cylinders and valve chest castings, and calls for little explanation. The leading feature is the small starting ports formed in the piston valve line—illustrated by Fig. 4 *ante*—and not shown in the cylinder drawing, though attention is drawn to the cored recess in the side of the steam ports to permit of the steam coming through the ports getting into the main steam passages to the cylinder. The arrangement of the main steam connections and of the exhaust passages, the latter being entirely clear of the cylinder barrels, are well shown. The cylinders themselves are fitted with liners or bushings $\frac{3}{4}$in. thick, made of a special grade of hard cast iron specified to be cast on their ends 4in. longer than required, and to be pressed into position.

The standard type of piston valve is shown by Fig. 8. The main feature is its light weight, no more than 117 lb., compared with the type which it replaces, weighing 253 lb., for former 16in. valves used on the locomotives for which the present 12in. valves are now standard.

The packing rings are of cast iron, the spiders are of cast steel, and the centre is composed of solid drawn steel tubing, having trumpet-shaped ends, made from boiler plate material welded to the tube section. Two $\frac{3}{4}$ bolts hold the valve parts together, and the whole is threaded over the main valve spindle in the usual way. The valve travel in full gear is 6in., and in order to obtain the 50 per cent. cut-off the steam lap is 2in. The lead in full gear is $\frac{3}{16}$in. and there is an exhaust lap of $\frac{1}{4}$in. The auxiliary ports are $\frac{1}{4}$in. by $1\frac{1}{2}$in. They are $1\frac{3}{4}$in. in advance of the main ports, and are cut in the valve liners at the bottom. They have a steam lap of $\frac{1}{4}$in.

THE MOTION.

The motion arrangement is shown by Fig. 9, and details of the crossheads and the unusual form of slide bars designed to meet the special conditions arising through the use of the large diameter pistons and high steam pressure employed, is shown by Fig. 10.

The connecting and coupling rods, the piston-rods, and the valve gear details are made from heat-treated alloy steel forgings, and have been carefully designed with a view to eliminate unnecessary weight. The main crank pins and also those for coupling rods are made from heat-treated steel, and are, in addition, hollow bored. In order to show how comparatively small is the amount of metal used, some particulars of the connecting-rods will be given. The rods are 11ft. $1\frac{1}{2}$in. long between centres, and have crank pin end bearings 10in. diameter by $8\frac{1}{2}$in. long, and at the crosshead ends $6\frac{1}{2}$in. diameter by $6\frac{1}{2}$in. They are of fluted section with a $\frac{7}{16}$in. web and flanges $4\frac{1}{2}$in. by $1\frac{5}{16}$in. at the small end, and $4\frac{1}{2}$in. by $1\frac{9}{16}$in. at the crank end. The total depth at the small end is therefore $9\frac{1}{2}$in. and at the crank end $9\frac{7}{8}$in. The rods are of the open ended description, being machined out to $10\frac{1}{2}$in. for a length of $13\frac{1}{2}$in. at the fit for the crank pin brasses and having cross sections at this point of $2\frac{1}{2}$in. by $6\frac{1}{4}$in. wide. At the back end where the retaining bolt and cotter are fitted the section is increased to 4in. by $6\frac{1}{4}$in.

The piston-rods are hollow bored, and the pistons are of forged steel, and are fitted with three cast iron packing rings. They extend through the front covers and are fitted with slippers sliding on suitable guides.

The cross heads and their guides form probably the most novel and original feature of these locomotives, in so far as the motion is concerned. The earlier locomotives of this type were equipped with two bar guides and the "Alligator" type of crosshead. These were one piece steel castings, and provided top and bottom bearing surfaces 35in. by 9in. with an area of 315 square inches. The total maximum piston load reaches the extraordinary figure of 182,655 lb., which, with connecting-rods 11ft. $1\frac{1}{2}$in. long, gives a maximum vertical thrust on the crossheads of about 22,000 lb., and for this type of crosshead a bearing pressure of 69.8 lb. per square inch.

With a view to reduce the unit bearing pressure the new type of crosshead, illustrated by Fig. 10, was constructed. A width of 10in. is the maximum available for the guides. It will be seen that the new crosshead, which is made from a single steel casting, has two bearing ribs or flanges. They are 35in. long, and provide a total area, not counting radii, of 726.25 square inches for upward thrust—that is, when the engine is moving in forward gear, and 376.25 square inches for back gear operation. The crosshead weighs complete with pin 875 lb.; neglecting this weight and assuming a total thrust of 22,000 lb., the unit bearing pressures are, in fore gear 30.4 lb. and in back gear 58.5 lb. per square inch. A further feature of these crossheads is the hollow bored pins of heat treated steel, which also form the bearing for the union link. The pins are put in from the outside, and are provided with taper fits, and a short key to prevent rotation. They are $6\frac{1}{4}$in. by $6\frac{1}{2}$in. where they form the connecting-rod small end bearing, and $3\frac{9}{16}$in. by $2\frac{1}{4}$in. long at the bearing for the union link. The outer ends are bored $2\frac{1}{4}$in. and the centre $4\frac{1}{2}$in.

The pin is firmly held in position by a steel retainer casting, which is drawn hard up to a seating on the outer end of the pin and held by three $\frac{7}{8}$in. studs in the crosshead casting. Lubrication is effected by solid grease, which is forced into the interior of the pin by a plunger fitting the small bore of the outer end, and screwed up by a square-ended screw which is threaded through the retainer casting. The inner end of the pin is closed by a hollow cast iron plug somewhat egg-shaped, which reduces the cavity in the pin and at the same time helps to feed the solid lubricant through two $\frac{3}{4}$in. holes drilled through the pins to the front and rear of the bearing. The grease is put into the bore of the pin through a slot at the outer end, and the corresponding slot of the retainer casting is covered by a flat steel spring.

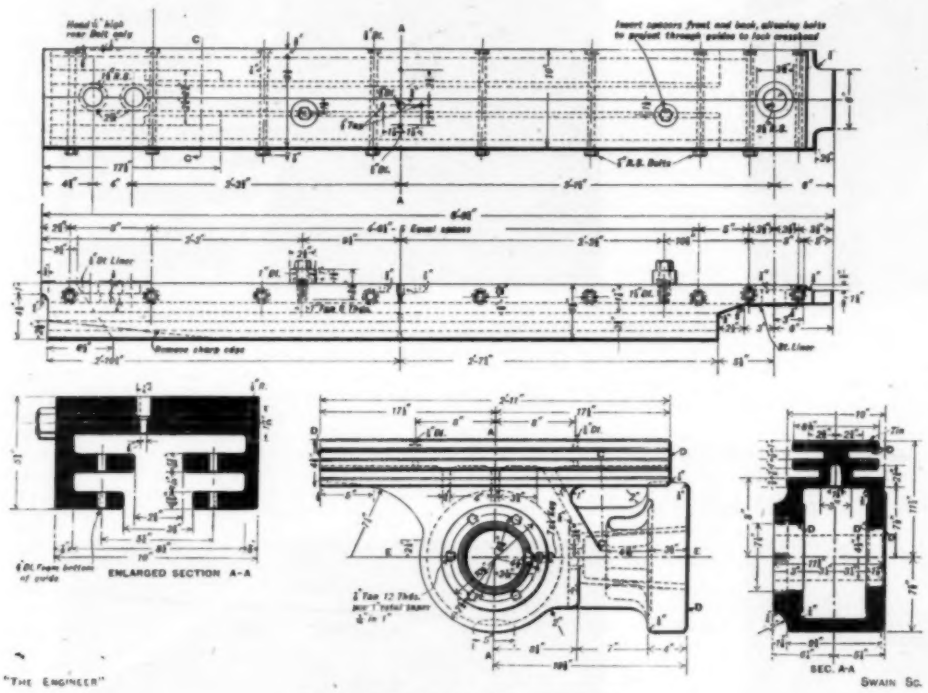


FIG. 10—SLIDE BARS AND CROSSHEAD

The slide bars designed to suit these crossheads are also shown by Fig. 10, which is self-explanatory. They are made in two sections as shown, in order to facilitate machining, after which they are securely bolted together. Compared with the "Alligator" type of crosshead and two bar guides which they replace, the new design provides bearing areas which are 230 per cent. of the old type for upward thrusts and 120 per cent. for downward thrusts.

TENDER.

The tender weighs when fully loaded 182,000 lb. and runs on two four-wheeled trucks, having 33in. rolled steel wheels; the journal bearings are 6in. by 11in. They carry 9000 U.S. gallons of water and 17.5 tons of coal, or 350,000 lb. A water scoop is provided. The total weight of the engine and tender in working trim is 547,000 lb., or 244 English tons. Both the engine and tender are fitted with the Westinghouse automatic air brake.

OPERATING CONDITIONS.

There are at the present time about 600 of the 2–10–0 Class I 1 s locomotives in heavy general goods and coal traffic on the Pennsylvania system. The majority of them are employed on the Western Pennsylvania Division, a section which comprises the 114 miles of main line between Altoona and Pittsburg, with its various branch lines. The gradients on the main line are severe, more especially between Altoona and Conemaugh, 35 miles, where the line passes over the Alleghenies. The first 12 miles going west from Altoona are on continuous rising gradients of from 1.73 (1 in 58) to 1.98 per cent. (1 in 51) to the summit at Gallitzin. The main line for practically the entire distance between Altoona and Pittsburg consists of four tracks, the fast and slow lines going east and west are adjacent to each other, the west-bound tracks being on the right travelling in that direction.

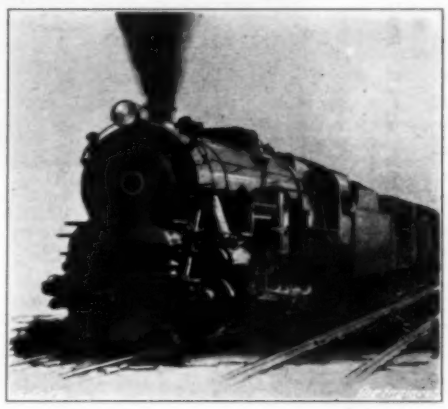


FIG. 11—50 PER CENT. CUT-OFF ENGINE IN SERVICE

The tonnage rating for the 2–10–0 type locomotives on the main line are as follows:—Westward: from Altoona to Gallitzin, 1180 adjusted tons; from Gallitzin to Derry, 4365 adjusted tons; from Derry to Pitcairn or Pittsburg, 2450 adjusted tons. Eastbound: from Pittsburg or Pitcairn to Derry, 2020 adjusted tons; from Conemaugh to Gallitzin, 2020 adjusted tons; from Derry to Conemaugh, 4755 adjusted tons. From Conemaugh to Gallitzin, 23 miles, going east, the mountain rating for one 2–10–0 and two 2–8–2 locomotives is 5230 adjusted tons. The 2–10–0 engines can handle this load unaided over the 33 miles between Derry and Conemaugh. The tonnage out of Altoona going west is 3020 adjusted tons, and to get this load up to Gallitzin requires three locomotives, one 2–10–0 Class I 1 s and two 2–8–2 Class L 1 S. From the summit at Gallitzin to Derry, 56 miles, the I 1 s locomotive hauls the load without assistance. The average speeds maintained by the 2–10–0 type locomotives varies with the class of traffic being handled, and is 10 miles per hour with slow goods trains, and 40 miles per hour when employed in "preference" or "fast" goods services.

The Western Pennsylvania Division and its various branches despatches as many as 12,000 loaded cars per day, and loads as many as 4300 cars of coal alone, in addition to 1200 cars of coke. The total daily goods movement over the Allegheny Mountains and past Gallitzin has amounted to 3200 cars going east and, in addition, 3500 westbound. This is equivalent to moving more than two cars each way for every minute of the twenty-four hours.

An idea of the appearance of one of these powerful locomotives at the head of a train is given by Fig. 11.

THE Commercial Secretary at Santiago, Chile, reports to the Department of Overseas Trade that, according to *El Mercurio*, of March 14th, 1925, the Minister of Ways and Works has presented a project of law to the Chilean Government for the construction of 240 bridges at a cost of 37,000,000 dollars. The project provides for the execution of further works of a similar nature. According to local law, the municipalities and local proprietors benefited by these works must contribute 50 per cent. of their cost.

MANAWATU GORGE ROAD, NORTH ISLAND, NEW ZEALAND

MESSRS. JICKELL AND GILMOUR, PALMERSTON NORTH, ENGINEERS

(For description see opposite page)

A PORTION OF THE ROAD BEFORE WIDENING

CONSTRUCTING SUPPORTING COLUMNS

ONE OF THE BENDS IN THE WIDENED ROAD

A PORTION OF THE COMPLETED ROAD

Road Reconstruction in New Zealand.

THE precipitous and treacherous sides of the Manawatu Gorge, which lies between the towns of Palmerston North and Woodville, in the North Island of New Zealand, have long presented a danger to passengers using it to travel between the west and east coasts of the Island. The traffic between Manawatu on the west and Hawke's Bay on the east has, however, grown considerably during the past few years, and with the increasing importance of both provinces—Wellington and Hawke's Bay—industrially and commercially, the Gorge as a thoroughfare for transport has come into great prominence, and that, together with its scenic beauties, caused the road traversing it to become a main highway in fact, if not in name. Accordingly, a few years ago the decision was arrived at to make the road safe and serviceable throughout, and the illustrations on page 552 give an excellent idea of the work, two of them showing that portion of it that was formerly one of the most dangerous spots.

The matter was taken up in earnest by a Commission over four years ago, and on March 29th, 1920, Messrs. Jickell and Gilmour, engineers, of Palmerston North, presented a report upon the length of road from end to end of the Gorge. It appears that the length of the roadway from the western end of the upper bridge to the western or lower end of the Gorge proper is 4½ chains short of 3¾ miles, whilst from the first-named point to the western end of the lower bridge is 3.17 chains short of 4¼ miles. The report stated that the hillsides, both above and below the roadway, had been thoroughly examined, and that it was found that in many places it would be extremely dangerous to carry out widening work by means of excavating the rock of the slopes above the road, as, if that were attempted, it would be likely to involve the Commission in great useless expenditure in removing the slips caused by the operations. It was pointed out that in past years many thousands of pounds had been expended at various times in removing slips, that the cost had embarrassed the funds of the two County Councils concerned, and that the slips had caused great inconvenience to the general public, on account of the closing of the road on various occasions, sometimes for a lengthy period. For these reasons it was advised that it would be unwise to attempt excavating operations at any part where there was the slightest likelihood of disturbing the stability of the hillside above the roadway, although at many other points, especially towards the eastern end of the Gorge, it was quite safe to excavate without damage ensuing, and that advantage should be taken of that fact to widen the road in that way. Where such widening was safe, it was proposed, by the removal of points and projections, to straighten the road as much as possible, and the total length of rock cutting involved was 5650ft.

Above the roadway the excavated faces of the rock on the hillside were found to have batters of from ¼ to 1 to ¼ to 1, and they were somewhat shattered, owing to the use of explosives for the original work. At several points, too, there were loose portions of rock which were dangerous and liable to fall on to the road at any time. These loose portions, it was recommended, should be removed, as they were a menace to the users of the road. Below the roadway, the original undisturbed rock faces stood at slopes of from 50 deg. to 80 deg. from the horizontal, with the exception of three or four short lengths where the faces were practically vertical. This rock below the road being unshaken, was deemed to be quite suitable for the foundations of the projected works, which would be well above flood level.

The conclusion having been arrived at that, as it was a main arterial road, its width should be increased, the engineers carefully examined various means and methods by which the work could be best accomplished, having regard to the financial aspect and to the amount of money that was likely to be available for the undertaking. It was eventually recommended that the major widening should be made at the outer or river side of the roadway by means of concrete cribwork, comprising reinforced concrete slabs, supported on reinforced concrete beams and columns. The slabs of this cribwork, it was proposed, should be supported at the inside on the solid rock, and at the outer or river side on the reinforced columns, and that that part of the structure should be designed safely to carry a moving load—traction engine—weighing 15 tons, together with the dead load of the slabs and the superimposed road materials. The total length of this proposed cribwork was 13,417ft., and the effective width varied from 3ft. to 12ft. to suit the inner positions of the rock foundations.

All the original bridges were constructed of timber, and they, with one exception, were in anything but good repair. It was proposed to replace them with reinforced concrete construction, similar to the cribwork—with slab decks and column supports. No pile driving was required on any part of the work, since all the columns could be founded on the solid. At one point, in order to avoid a very bad convex bend, it was proposed to bore a tunnel 151ft. long, 16ft. wide and 20ft. high. The metal used along the whole length of the new widened part of the roadway was to be taken from the rock cuttings, and broken to 1½in. cubes before being spread in position, and the whole of the shingle for the concrete was to be won from the river bed by means of a standing wire rope, skips and gins, with horse haulage.

Estimates for two widths of roadway, 21ft. and 18ft., were put forward, but it was strongly recommended that the wider roadway should be adopted. It was estimated that the cost of a 21ft. roadway, without hand-rail, kerb and tarred surface, would be £24,285, or with hand-rail, kerb and tarred surface, £37,964; and that of an 18ft. roadway without hand-rail, kerb and tarred surface, would be £24,218, or with hand-rail, kerb and tarred surface, £29,059.

The scheme proposed by the engineers was ultimately adopted by the Board of Control, and a road 21ft. in width was chosen. It was agreed that the surface should be tarred, and that a hand-rail should line the outer edge of all the dangerous parts.

The work was commenced in April, 1921, but during the first year only £3000 was spent, because the local bodies contributing towards the maintenance of the road had to wait for the completion of the necessary formalities regarding loans. Then unpropitious weather conditions delayed operations, and on many occasions only half-time was worked. Labour also was one of the factors in the retarding of progress, for it was at first very difficult to retain good men because the conditions were very bad in winter time. On some days, it is stated, the sun does not reach certain portions of the road. An abundance of accommodation was provided, however, and the present staff is progressing well with the construction of the road.

The engineers, Messrs. Jickell and Gilmour, state that the date of the completion of the scheme will depend largely upon the weather and the condition of the labour on the job. Last spring and summer the labour secured was of a high order, and advantage was taken of the fine weather to push the construction forward. If everything goes well, it is estimated that it will be completed in the autumn of this year.

The Government having undertaken to subsidise the work to the extent of £1 to every £2 expended on it, the Public Works Department at one stage intervened, and advocated a reduction of the width of the road to 18ft. in view of the less expense involved. Engineers were sent up to take surveys, and it was recommended that the road should be cut from the hill instead of being built out, as recommended by the engineers. Alternative plans were submitted to the Board of Control, but on consideration of them, the members decided to remain firm in their acceptance of the original proposal. The Government then decided to subsidise up to £32,000 only.

South African Engineering Notes.

Union Railway Budget.

The total expenditure of the railways, harbours and steamships of the Union for last year amounted to £23,876,217. It is estimated that, when the accounts are made up, the revenue will be approximately £24,626,000, giving a surplus of £930,000, which would wipe out the accumulated deficit of £770,000, and leave a balance of £160,000. The expenditure for 1925–26 is estimated at £25,301,143, or £1,393,015 greater than the original estimate for 1924–25; the revenue is estimated at £25,341,838, which would give a surplus of £40,695, and with the £160,463 from last year, would mean a total surplus of £201,158. The total number of staff employed by the Railway Administration at December 31st, 1924, was 86,481, an increase of 6398 on the number employed at December 31st, 1923.

Gas for Johannesburg.

The Johannesburg Municipal Council has just adopted a scheme of gas development, involving a total expenditure of £350,000, which has been submitted by Mr. H. J. Ibbotson, M. Inst. C.E. The amount is made up as follows:—One million cubic feet plant arranged for extension, so as to produce two millions, £220,000; distribution, £115,000; engineering fees, contingencies, &c., £15,000. In his report on the proposed extension of the gas undertaking, Mr. Ibbotson, dealing with the potential purchasing capacity of Johannesburg, with regard to gas, stated that the quantity of gas manufactured at the municipal works during the year 1909–10 was 23,875,200 cubic feet. That figure had grown in 1921–22 to 83,646,500 cubic feet, representing an increase of 350 per cent. in twelve years. An unusual feature is the average consumption of gas per meter, which for 1921–22 amounted to no less than 129,000 cubic feet, or four times the average consumption in the United Kingdom. Estimating the number of consumers, it is shown that the white population of Johannesburg was 119,953 in 1911, 137,116 in 1918, and 149,653 in 1921. Assuming that rate to be maintained, the population should this year be 160,000, in 1930 about 176,000, and in 1935 approximately 190,000. The potential business in Johannesburg to-day is 24,000 services, and, after making all allowances, Mr. Ibbotson is of opinion that 20,000 services could easily be obtained. Such a development of the gas supply would, he is confident, make no difference whatever to the Electric Supply Department. There is, he maintains, no foundation for the statement that the progress of gas supply is largely due to its having been established before the advent of electricity. It is essential, Mr. Ibbotson considers, that a plant capable of producing four million cubic feet per day should be provided for an average sale of 3,000,000ft. per day. It is not, however, his intention to recommend a unit of four millions, though he is confident that that "make" could be exceeded in eight or ten years from the commencement of operating conditions. He considers it reasonable to assume a maximum daily demand of 500,000 to 600,000 cubic feet by the completion of the erection of the new works, and he therefore recommends the installation of a manufacturing unit of one million cubic feet capacity, designed for extension to two millions per day, and is satisfied that the extension will have to be commenced within about three years of the completion of the first proposed unit.

Rolling Stock for South Africa.

In view of the continued expansion of traffic and the further increased demands likely to be made upon the rolling stock of the railways of the Union of South Africa, the Administration has taken steps to secure the early delivery of new rolling stock, including 38 engines and 646 goods vehicles. Tenders have also been invited for the supply of an additional 14 engines, while the question of further increasing the number of goods vehicles is receiving attention.

Union Irrigation Development.

The Union of South Africa is now nearing the end of a four-year period of constructive activity which has never been exceeded, and is hardly likely to be equalled again in the history of irrigation development in the country. During the last couple of years exceptional numbers of large storage dams have reached the stage of completion. Thirteen only of them represent a combined storage capacity of 535,000 acre-feet. Some of the reservoirs formed by the dams filled almost immediately after completion. Taking the technical aspects of the large number of works recently completed, there are many novel, and possibly bold, features in design and execution. Hartebeestpoort, which is the highest dam in South Africa, and the only example of the use of the varying radius, may be mentioned. Incidentally it was at the time of its design the thinnest dam in the world at a depth of near 200ft. At Lake Arthur and Van Rynevold's Pass, where concrete overflow dams of a height exceeding 100ft. have been built, the stepped downstream face embodies new features in dam design, and at the former dam a new process of grouting is of interest. At Lake Mentz the use of concrete of a strength of only 1.5 to 10 is a bold innovation. Amongst earthen dams the extremely slender cut-off walls at Grassridge and Kaffir River, and the design of the Lake Marais Dam on poor foundations are interesting. In the case of the Hartebeestpoort Dam, the temperature and deflection observations which are now being taken are noteworthy. Lake Arthur is the second of the great storage schemes in the Cradock district of the Cape. The dam has yet to have an additional 10ft. built up on the crest for about two-thirds of its length. It will then be completed. The present capacity of the reservoir is about 40,000 acre-feet, but when the dam is finished it will be 57,500 acre-feet. The temporary spillway, over which approximately 1,000,000 gallons per minute were pouring when the writer recently visited the work, is about 470ft. long. Instead of falling in a single mass, the water is broken up into sections. The face of the wall is formed of steps, and the water whilst pouring over the solid wall falls on to these steps which break it up. At present the depth of water is just over 68ft. over the outlets.

Modified Fairlie Locomotive.

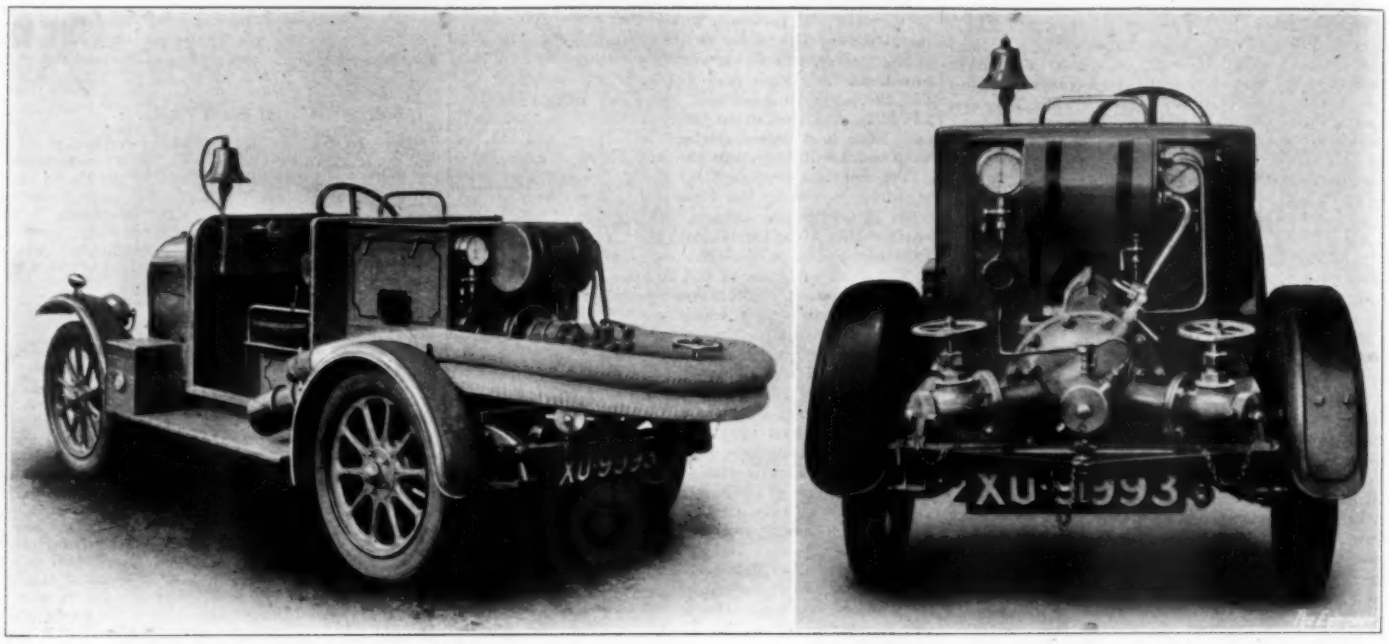
A modified Fairlie locomotive, built on similar lines to the Garratt type, has been recently introduced by the Administration for working on the Coast lines in Natal. The boiler is mounted on an independent plate frame and pivoted above the intermediate coupled wheels of the front and hind engines—an arrangement which is slightly different from that of Garratt the type in which the boiler is pivoted practically above the trailing wheels of both engines. The boiler is similar to the Garratt-Belpaire type, and is fitted with a Smidt type of superheater and air valve. Electric light is supplied to the head lamps and cab by a Pyle National turbo-generator of the K 2 type, mounted on the fire-box. From the boiler, steam is supplied to the fore and aft engines through a steam pipe fitted with ball points. The front and hind engines are fitted with bar frames, to which the cylinders, which are 14in. in diameter, are attached. All the coupled wheels are of 3ft. 6½in. diameter, the driving wheels in each case being intermediate. Both front and hind tanks of the modified Fairlie are carried in a different manner from the ordinary Garratt method, being fixed to the boiler frame so that they overhang the engine frame to permit of free movement when rounding curves. The brake gear is acutated by steam cylinders of 10in. diameter by 8in. stroke, affording a braking power of 35 tons, and is carried about the centre of the boiler frame. A hand brake is also fitted in the cab for use when required. The special fittings provided include Wakefield mechanical lubricators; Lambert steam-sanding gear; reversing steam cylinders; and steam operated fire-grate shakers.

What Gold Mines Spend.

During 1924 the gold mines on the Witwatersrand expended £13,250,185 on stores, an increase as compared with the previous year, of over £300,000. Foods supplied free to coloured labourers cost £1,088,842, of which mealie meal and Kaffir corn represented £430,173, and 35,379,779 lb. of meat were purchased at a cost of £350,098; bread amounted to £176,758; vegetables, £58,153; groceries, £43,939; beans, £38,754; malt and cereals for beer, £28,271; fish, £10,073; rice, £8787; and salt, £2311; fodder for stables amounted to £32,423; and coffee, &c., supplied free to white employees, £8139. Among big items in the mine's stores accounts are explosives, £1,871,610; electric light and power, £1,622,811; coal, £1,023,158; timber, £961,499; machinery and machine tools, £451,393; electrical machinery, £434,458; electrical machinery spares and fittings, £100,159; machinery spares, other than electrical, £354,713; pipes and pipe fittings, £442,069; rock-drill spares, £410,299; rock drills, £124,966; cyanide, £320,982; compressed air, £391,089; and steel, £488,723.

LIGHT MOTOR FIRE ENGINE

GWYNNES ENGINEERING COMPANY, LIMITED, HAMMERSMITH, LONDON, ENGINEERS



A Light Motor Fire Engine.

We recently had an opportunity of inspecting the neat little fire-engine, which is illustrated by the engravings below, and is being manufactured by Gwynnes Engineering Company, Ltd., of Hammersmith. The engine is intended for service in small country towns, or large estates, where the outlay on a full sized machine would not be warranted, and where handiness and high road speed are specially advantageous.

The chassis on which the pump is mounted is the same as that of the "Gwynne 8" light car, with some extra cross members arranged between the side frames to carry the concentrated load, while additional leaves are fitted to the back springs, and the Dunlop tires are filled with Rubberine to avoid troubles through punctures. The engine is of the four-cylinder type, with a bore of 56 mm. by 100 mm. stroke, and is nominally of 7.6 horse-power, but it will develop 15 horse-power at 2000 revolutions per minute. It has overhead valves operated by push rods from a cam shaft in the crank cases. The water-cooling is of the normal thermo-syphon type, but there is also a special connection from the fire pump to the engine jacket for circulating water when the machine is standing and the pump is at work. Otherwise the engine is similar to that fitted on the standard car, and can drive the fire-engine at 45 miles per hour on the road.

The pump, it will be seen, is mounted at the extreme rear of the chassis. It is of the two-stage turbine type, with the impellers arranged back to back to minimise end thrust. It has a central suction 3in. in diameter and two 2½in. discharge branches arranged on the cover facing the rear of the machine. The duty is 100 gallons of water a minute pumped against a pressure of 100 lb. per square inch when running with 3000 revolutions per minute. It will also supply two jets with 140 gallons per minute at a pressure of 60 lb. per square inch. The pump itself is of gun-metal, with a stainless steel spindle, so that there is no fear that it will rust up. The main bearing is of the roller type, while the end of the spindle is supported in a plain grease-lubricated bearing arranged in the suction passage. A double thrust washer is provided to take up any slight unbalanced end pressure, and is cooled by the circulating water on its way to the engine jacket. There are a strainer and a non-return valve in this connection.

The pump is primed by means of a rotary air exhauster, which is driven from the pump spindle through friction wheels. The intermediate wheel of this drive can be brought into the working position by means of screw gear. There is, between the exhauster and the pump, an interceptor tank fitted with a ball float and valve in such a way that water is prevented from getting into the exhauster when the main pump is fully primed.

The driving connection for the pump is arranged on the engine side of the ordinary gear box, and its wheels are always in mesh. There is, however, a drag clutch for engaging this train of wheels with the shaft driving the pump, which runs above the usual propeller shaft and is provided with two universal joints. The gear wheels increase the engine speed up to 3000 revolutions per minute at the pump spindle, and are so interlocked that the road wheel gears cannot be engaged while the pump is at work.

The engine is provided with two 10ft. lengths of 3in. suction hose, which is stowed round the pump—as shown in one of the engravings—while the delivery hose, nozzles, &c., are kept in the box. Besides the driver and fireman sitting alongside, the engine is capable of carrying two extra men standing on the running boards.

Vancouver's largest grain elevator, which has a capacity of 2,225,000 bushels, and measures 269ft. by 108ft. by 115ft. high, was, according to the *Contract Record*, built in forty-five days.

A Pitting Gauge.

When discussing a paper on "The Factor of Safety of Boilers," read before the South African Institution of Engineers by Mr. T. E. C. Stanton, Mr. W. O. Andrews pointed out the difficulty of deciding if the corrosion of boiler plates was proceeding actively or not between consecutive inspections, unless some method of actually measuring and recording the extent to which the corrosion has progressed were adopted.

For this purpose he had used the simple little gauge shown in the sketch below—reproduced from the *Journal* of the Institution—which had been devised by Messrs. V. Pickles and G. Hall. The construction of the instrument is so obvious in the drawing that it hardly needs any description, but it may be pointed out that the magnification between the steel pin, which is pressed down into the pitting by a spring, and the pointer, is such that the depth of the pit can be easily read to one-sixty-fourth

THE PICKLES AND HALL PITTING GAUGE

of an inch. The length of the base is amply sufficient to ensure that the datum level represents the general surface of the boiler plate.

At the power station of the Victoria Falls Company the boilers are opened up every three or four months and the whole surface of the plates is explored by means of one of these instruments. A map, or developed plan, is then made, showing the position and depth of any corroded patches, and by comparing these maps from time to time the progress of the corrosion can be quickly and certainly decided, so that appropriate action can be taken to meet it.

THE OBERHASLI HYDRO-ELECTRIC PROJECT.

The Bernese Power Company has completed the plans for a large hydro-electric project in the Oberhasli region of the Bernese Alps. An account of the project, with a diagram, and a contoured map of the larger of the two lakes to be utilised, is given in the January 10th and 17th issues of the *Schweitzerische Bauzeitung*. The lakes, which will be used for storage, are Lake Grimsel and the Gelmersee. The former, which is on the upper Aar, will have its water level raised from alt. 1875 m. to alt. 1912 m., and its capacity increased to 100 million cubic metres, by the building of an arch dam, the greatest height of which is to be 110 m. from foundations, and which will have an upstream batter of 1 in 10 and a downstream batter of 1 in 2. The depth of water over the outlet will be 82 m. The volume of the dam will be 340,000 cubic metres, and there will also be a bund having a volume of 58,000 cubic metres and a length of 290 m. The Gelmersee will be raised from alt. 1822 m. to alt. 1852 m. by a mass gravity dam, having a crest length of 385 m. and a volume of 78,000 cubic metres, the capacity of the lake being increased to 13 million cubic metres.

The total fall from the Grimsel outlet to the lowest of the three power stations, at Innert Kirchen, is 1212 m., and the actual minimum falls above the three stations, in downstream order, are:—515 m., Handeck; 412 m., Boden; and 241 m., Chateau d'Eaux (Innert Kirchen), the horse-powers being respectively 100,000, 88,000 and 56,000. A tunnel 2 m. in diameter and 5250 m. long will connect Lake Grimsel with Lake Gelmer. From Handeck the spent water will be led by a tunnel, 3 m. in diameter and 1564 m. long, to the pressure pipe of the Boden station, the spent water from which will reach the pressure pipe of Chateau d'Eaux by a tunnel, 3.1 m. in diameter and 4486 m. in length. The average annual quantities of water utilised at the three stations, in the same order, will be 210, 232 and 255 million cubic metres. Three-phase alternators will be driven by vertical axis turbines, four units at each station, and the current transformed from 7500 to 50,000 volts, for transmission. A part of the transmission line, which will be in a place exposed to danger from avalanches, will be in an accessible tunnel. Since work on the dams can only be done in the summer, it is expected that it will take eight years to complete the works, the cost of which is estimated as 82 million Swiss francs.

Thin-Lead Coloured Pencils.—We have received from Alpco Pencils, Ltd., of 173-5, Lower Clapton-road, London, E. 5, which is the general agent for the products of the American Lead Pencil Company, samples of three thin-lead coloured pencils. To these pencils the name "Unique" has been applied, and the colours at present available are red, blue and yellow. The pencils are of hexagon form outside, and the "leads," which are circular, are little, if at all, larger in diameter than are ordinary leads. We have given them a good trial and find them quite satisfactory. They are a little harder than the average blue pencil, but they are exceedingly pleasant to write with, and the fact that they are not too soft results in it being necessary to sharpen them all the less frequently.

Belfast Association of Engineers.—A party of eighty-two members of the Belfast Association of Engineers visited the works of Harland and Wolff last week. Great interest was taken in the new double-acting Diesel engine which has recently been built by the firm, and also in the parts of other engines of the same size which are under construction. These engines have eight double-acting cylinders, 2ft. 9in. bore, with a piston stroke of 4ft. 11in. They develop 10,000 indicated horse-power at 115 revolutions per minute and are the largest Diesel engines which have yet been completed. A vote of thanks to Harland and Wolff, Ltd., was passed by acclamation, and in replying on behalf of the firm Mr. Atholl Blair (engine works manager) intimated that they hoped shortly to extend a further invitation to the members of the Association to witness the trials of the next completed engine.

Vickers Westminster Amateur Operatic Society.—We had the pleasure of attending the first of three presentations of the comic opera "Merrie England," which were given at the New Scala Theatre in London on Thursday, Friday and Saturday, April 30th and May 1st and 2nd, by the Vickers Westminster Amateur Operatic Society. To undertake the present tion of such an opera was certainly an ambitious venture for an amateur society, but it must be said that it was wonderfully successful. To attempt to give any detailed criticism of individuals would be impossible, seeing that the cast numbered twenty-three, and that there were over fifty "Lords, Ladies, Men-at-Arms, and chorus." We must, therefore, content ourselves with a general reference. To begin with, then, the singing was, for the most part, good, though some of the voices were not quite powerful enough to fill such a large theatre, and, almost without exception, the performers failed to come far enough forward on the stage to project their voices into the auditorium to the best advantage. But that is the most serious criticism we have to make. Some of the acting was really good, and all the singers and speakers, without exception, were apparently word perfect. Furthermore, the chorus, both in singing and gesture, was well together; and, finally, the scenery was pretty and the dresses effective. In fact, it can well be said that the whole performance was most meritorious, and the success of the evening, which we thoroughly enjoyed, was in no little measure due to the Vickers Westminster Orchestra and its energetic conductor.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Improved Tone Upheld.

THOUGH the slightly more hopeful tone recorded last week as existing in the iron and steel and engineering industries of the Midlands and Staffordshire persists, in no department of trade is much business being done. The general tendency is to buy only for current needs, and, until prices become more settled, no change in this respect is anticipated. There is an impression that values are now approaching a business basis. It is still possible get concessions under most heads, but apart from this the normal quotations are recognised as approaching stability. This is all to the good, but whether a steadying of prices would of itself be very influential in promoting freer market conditions is a debatable point. The vital factor is that the volume of demand is so inadequate to productive resources that competition keeps the market from settling down on a firm economic basis.

Staffordshire Bar Iron.

The Staffordshire ironworks are only partially engaged, the lack of wrought iron orders being to some extent supplied by business in re-rolling steel. The makers of marked bars continue moderately busy, and their basis rate of £15, which has been quoted without a change for a full year, is maintained without difficulty. This is, however, one of the few departments not subjected to competition from abroad. The recent lowering of bar prices in Scotland has provoked some speculation as to a possible fresh alignment in the Staffordshire district. There is no present indication of any move. On the very slender basis of production which now prevails, bar makers cannot afford to make reductions, except with the reasonable probability that they would promote a greater demand, and there is no encouragement for such a view in the present condition of trade. Wrought iron continues to be preferred in certain quarters, especially for exacting engineering requirements, but steel, steadily reducing in price is a more formidable competitor. In the lower qualities for fencing, nuts and bolts, &c., Belgian No. 3 iron can be bought here at £7 5s., or nearly £4 below the Staffordshire common bar. A lot of this is bought through merchants, and users appear to prefer this system, because they can obtain credit from merchants against cash terms required by the Belgian manufacturers. Wrought iron gas tube strip is in fair demand at £13.

Sheet Department.

Galvanised sheets continue a very favourable market, bookings having been made on the £16 10s. basis for 24 gauge corrugateds for export. The new orders more than counterbalance the output, and makers are therefore carrying fair reserves of orders into the summer period. The home demand does not keep up so well, but makers appear to have little difficulty in securing £16 15s. per ton at works, and quite an appreciable volume of business comes along spasmodically.

Raw Iron.

The pig iron situation has not altered very much, and the weakness of this branch of industry is apparent. There is very little call for iron, either foundry or forge grades, and values are precarious. Where there is pressure to sell prices lower than those generally recognised are accepted. The re-starting of two North Lincolnshire furnaces does not denote any substantial broadening of demand. It means that other furnaces will suffer to the extent of the new production at that point. The small business being done is on the basis of £3 10s. for Northamptonshire No. 3 and £3 15s. for Derbyshire. Buyers are keeping back their orders until the last moment, hoping for lower prices. Further reductions are not considered unlikely, for furnace coke is weak, offers having been made as low as 14s. 3d. in this district, as compared with a basis of 15s. 9d. With the bulk of the furnaces out of action, fuel sales are small and stocks are plentiful.

Steel Business.

The chief feature of interest in the steel department on the week has been the plate situation, for the matter is of great importance to Birmingham engineers. Northern plate manufacturers have been making incursions into this district, offering ship, bridge and tank plates at £9. Many local producers, in order to cope with this competition, have expressed their willingness to accept the £9 5s. per ton, which, as reported last week, structural engineers were pressing for. This reduction in steel plates has, however, done little, if anything, to stimulate business. Supplies are greatly in excess of demand. There is only the slowest inquiry for boiler plates at £13. The steel works are moderately engaged, almost wholly on constructional steel. In a few cases they have old rail orders to work off on a system of periodical delivery. A fair aggregate of constructional steel is being turned out, largely in connection with municipal requirements, such as gas tanks, pipe lines, &c. Such constructional material as angles, tees and joists have varied in price little, if any, from last week. Nominally, they are unaltered, but they vary slightly according to specifications. Northern steel makers are offering sections at £8 7s. 6d., as against the local price of £8 10s. Some of the re-rollers are a little better occupied, but it would not appear that much more business is being received by the home makers of soft billets. Their price has dropped a little, some transactions having taken place at £6 17s. 6d., but £7 is about an average figure. With foreign material much cheaper, the bulk of the orders are going to Belgium. Belgian steel is still offered at prices quite impossible to Birmingham makers, and the continental market has weakened a little during the past week. Native bright annealed wire on the standard list has been reduced 1s. per cwt., making the basis 18s. in cwt. and half-cwt. coils.

Tin-plate Control and Billet Prices.

By the abandonment of the Welsh price stabilisation scheme and pooling system—which had existed for the past two and a-half years, and which was generally believed to be working well—as a result of underselling by some members, the Welsh makers are now deprived of the rebate of 7s. 6d. per ton on their semi-finished material, which was a feature of the stabilisation scheme. As foreign billets can be bought much more cheaply than Welsh, the Welsh steel works are likely to lose a portion of their market. These works now quote £6 15s. delivered in Birmingham. Welsh makers can buy from Belgium at £6, and sales have been made in Birmingham this week at £6 2s. 6d. Midland consumers who prefer British material are likely to wait for lower prices, which are considered a very likely development.

Steel Scrap.

Steel scrap is still weaker, £2 15s. being accepted free on rail, or £3 10s. delivered in South Wales. Consumers have still large stocks on hand, and are indisposed to make new contracts. There are still deliveries held up on old contracts. Continental suppliers continue to send small tonnages here for disposal.

Future of Bilston Steel Works.

It is announced that Alfred Hickman, Ltd., of the Springvale Blast Furnaces and Steel Works, Bilston, is going into voluntary liquidation, but, I learn, it is merely a matter of internal policy on the part of Stewarts and Lloyds, Ltd., of Glasgow and Birmingham, and of Coomb Woods, Halesowen, who have for some time held the whole of the shares of the firm. Springvale, which has employed so many people in the Black Country districts for many years, will continue as usual, but will be brought into closer touch with the well-known wrought iron and steel tube and pipe line and air tube firm of Stewarts and Lloyds for administrative purposes. It would appear that in future the output of Messrs. Hickman's Springvale Works is to be employed by Stewarts and Lloyds to supply the needs of their Coombs Wood tube works, while the steel needs of their Glasgow works will be met from the large new steel works they are now erecting on Clydeside at an expenditure of over a million sterling. The Coombs Wood works, I may say, cover some 30 acres, and give employment to 3000 hands.

Wages of Cannock Chase Miners.

The wages of the Cannock Chase miners for May remain the same as for April, and thus the minimum rate for stallmen is 10s. 4d. per shift. Other grades of workers in the same area engaged in and about the mines are also not affected by the latest ascertainment for the Eastern federated area, which is based on the output, selling prices, profit, &c., for the first three months of the year.

Warwickshire Miners and Subsistence Wage.

A dispute has arisen between the Warwickshire coalowners and the Warwickshire Miners' Association on a point in the award of the independent chairman of the Eastern Area Wages Board, with reference to the payment of the subsistence wage to loaders. The owners contend that the 4d. necessary to bring up the loaders' wages from 8s. 5d. to 8s. 9d. under the award should only be paid by them when the loaders are working in a stall which is on the minimum wage. The men's representatives dispute this reading of the award, and maintain that the 4d. should be paid by the owners, irrespective of whether the stall is on the minimum or not, and that it is not the business of the stallmen, where they are earning more than the minimum wage, to pay the increase. The Warwickshire miners' leaders further claim that as the subsistence wage will be an item of cost in the district ascertainments, and therefore not reckoned as wages, it should not be paid by the stallmen as wages. The parties have agreed to refer the matter for decision to the chairman of the Joint Wages Board.

Workless.

The unemployment returns for the Midlands, which have been pursuing a satisfactory downward course, with the exception of the holiday period, for some time now, unfortunately this week show a slight increase, the total figure rising to 134,904, as compared with 134,487 for the previous week. Of those out of work, 95,080 are men, 2895 boys, 32,848 women, and 4081 girls. In Birmingham the number unemployed is 27,936, an increase of 1608, and in Coventry 1384, a decrease of 6.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

THE iron and steel markets in Lancashire remain very quiet, and both merchants and manufacturers appear to be more depressed than ever. There is less business about in this district, although some of the reports from other districts seem to be a little better than they were. It seems now fairly probable that we are getting near the bottom prices in iron and steel; but if we take this to mean that the market is near a revival we may be making a mistake. Markets, after such upheavals as those of recent years, often have to remain at the bottom for a long time before any confidence is re-established; and this may be the case with iron and steel. In other words, although there may be steady prices there will be little hope of a return to active trade. One main difficulty in the British iron and steel trade is that it is arranged for a large export business, and that business is being taken away from it. The home trade could, of course, be protected, but the ultimate meaning of this would be that fully half the productive capacity of the country would be unemployed.

Metals.

The market in copper seems to be settling down again after its little attempt at improvement. These periodical spurts really do no good, but induce people to believe that copper is hopeless. There are reports of a large cut in the American production, but these are not yet confirmed; and the profit on much of the copper produced in America is still large enough to make voluntary reduction of output unpleasant. With refined copper at over £60 per ton, there appears to be a net profit of over £20 per ton on a good deal of metal produced in America. In the Manchester market there was a little spurt of buying when the prices threatened to advance, but it seems to have subsided since. Dealers in scrap metals make very little change in their prices. They did not follow the market when it rose, at any rate, to a corresponding extent, and consequently they are making little movement now. Scrap gun-metal is still selling at very much below its intrinsic value, and scrap yellow brass is also comparatively cheap. The movements in tin give no definite clue as to the actual position. It is no doubt true that the American consumption is large; but no one can say whether it is going to be large enough to stimulate the market. The statistical position is so far favourable, but there is no steady improvement, such as the position ought to bring about. The state of the market may be called "gusty." Business here seems confined mainly to small lots for immediate consumption. The market for lead has been a little firmer, and it is noticeable that the backwardation in forward delivery is not now very extravagant. Many people still look upon lead as too dear, but it is a question whether much lower prices can be expected for some time. Spelter remains steady and quiet, but without any special feature.

Pig Iron.

The market for foundry iron here remains in a depressed condition and very little new buying is reported. The position of the furnaces dependent upon the Lancashire consumption is certainly not so good as it was, and there seems to be rather keener competition for orders. To what extent this may bring down the price it is difficult to say, but there is no doubt that the feeling as regards prices is weaker than it was. A good many consumers here are now saying that the prices of No. 3 foundry iron in Manchester ought to be 80s. per ton at the most. Of course, it does not follow that these same consumers will buy freely at 80s. if and when the market does come to that figure. More probably they will then be prophesying 75s.; but under the existing costs of production, probably 80s. for No. 3 in Manchester is as low as any one has a right to expect. Many Derbyshire sellers are still trying for 83s. 6d. per ton delivered; but it is more and more evident that 82s. 6d. would be accepted at a pinch, and this is fast becoming the recognised price in Manchester. Foundry iron from Northamptonshire can come in at that price notwithstanding the high rate of carriage. Lincolnshire iron is quoted at 84s. delivered, but it is scarce, and foundry iron from the recently started furnaces has not yet been offered. It is believed that these furnaces will make basic iron at first; although there is not much demand for that class of iron. The price for Scotch No. 3 foundry iron remains nominally at 101s. 6d. per ton delivered here. It is possible that merchants who get a favourable chance of bringing the iron to Manchester Docks by water may be able to cut below 101s. 6d. There is, however, only a very limited demand for Scotch iron, and it will not be required to any large extent until the textile engineers get busy again. For East Coast hematite a little more is being asked here, but it can still be bought at about 7s. per ton less than Scotch iron.

Manufactured Material.

The position in the Lancashire bar iron trade does not improve, so far as the local make is concerned. Merchants seem to be doing fairly well with imports of foreign bars, but this cannot be considered satisfactory from the local point of view. With the existing competition, however, makers of bolts and nuts are simply compelled to use the cheaper material, however much some of them dislike doing so. For finished steel there is very little demand here, but the nominal prices have not been altered. Now that the different steel works are free from any control of prices it is not easy to be sure of the prices which are being taken. Naturally the tendency is to conceal those cases where any severe cut has been made. At a guess one would say that it is possible to buy joists and angles at £8 5s. delivered, and plates at £9 5s. Makers of reliable steel bars of sound section do not quote below £10, but bars can be had at about £9 to £9 5s.

Scrap.

The market for scrap, if it can be taken as indicative of the general state of business, is certainly a depressing factor. There is very little actual business going on at the moment, and prices are weak. Dealers seem rather nervous as to the future, especially in steel scrap, for which they pay 55s. per ton on trucks. Cast scrap is weak because of the position in the pig iron market, but dealers here are not inclined to reduce their prices. They quote from 80s. to 85s. for machinery cast scrap, according to quality, but the ironfounders are now talking of buying at 77s. 6d. and even at 75s.

The Engineering Wages Question.

A statement has been issued by the firms which constitute the Manchester District Engineering Trades Employers' Association, which explains the employers' proposal for lengthening the normal working week. This statement should help to remove any misapprehension which may have arisen as to how the proposed lengthening of the working hours will benefit both the employers and the workers. The only way to meet the demand for increased wages, it is stated, is by reducing production costs. To meet this, a working week should be increased from 47 to 50 hours, with payment for the additional three hours plus an increase of 2s. in the war bonus. The day rate worker at, say, one shilling per hour working the full number of the proposed hours will, at the end of the week,

draw 62s., compared with 57s. for 47 hours under the present system. Under the existing 47-hour week, a man rated at one shilling per hour, including the ten shillings war bonus, receives an hourly rate of one shilling 2.55 pence, whereas under the proposed scheme this hourly rate of pay, including the 12s. war bonus, would be increased to one shilling 2.88 pence. The 12s. bonus is paid *pro rata* for shortened or lengthened week, *e.g.*, if a man is rated at a shilling per hour and works only 47 hours instead of 50, his wages at the end of the week would be made up as follows:—47 hours = 47s.; proportion of 12s. war bonus, 11s. 3.5d., a total of 58s. 3.5d. On the present basis a man working 47 hours—a full week—at the rate of a shilling per hour, receives at the end of the week 47s. plus 10s. = 57s., or 1s. 3.5d. less than he would receive when working 47 hours short time under the 50 hours proposal. Men working under systems of payment by results will be able to increase their "piece" earnings in proportion to the extra hours worked, besides receiving an extra 2s. on their war bonus. The extension of hours and bonus will enable workmen to take home more money at the end of the week, and in no case will the workman suffer a reduction in normal weekly earning power. Employers have already given their promise to consider with the unions the question of reverting to shorter hours if other countries bring their hours effectively into closer relationship with those of this country.

BARROW-IN-FURNESS.

Pig Iron Dull.

A very quiet market, with no sign of an improvement, sums up the condition of the hematite pig iron trade. The North-West district is neither worse nor better than other centres of iron production, and the relief which some hoped the Budget would give to the producer and consumer, thus improving the trade, has not come. Makers are experiencing a thin market, and the whole of their output is not being cleared; as a matter of fact, there are increasing stocks at practically every works. Thirteen furnaces are still in blast, and it is a surprise that that number has been maintained, for less output would meet the demand. The fact that none have been damped down, has given rise to the hope that makers anticipate a better trade, but up to the present their anticipations have not been realised, and one may hear of restriction of output at any time. Scotch business is very dull, and the tonnage going to the Midlands is less. Other channels of business are dull.

Iron Ore.

The iron ore trade remains about the same. Most of the ore brought up is for local consumption, as the amount going out of the district is very small now. Foreign ores are arriving in moderate quantities, and the ore from Kirkenes is being regularly imported.

Steel.

The steel trade is in a moderate way, and the orders held will not carry the rail or sleeper mills very far. The Barrow rail mills have work for a few weeks, and at Workington the sleeper mills have an order to deal with, but as regards both places there is no bulk in the total orders held. The small section and hoop mills at Barrow are better circumstanced. Foundries are moderately employed.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

ALTHOUGH the aggregate amount of work being done in Sheffield is probably greater than in pre-war days, it is far from sufficient to provide full employment for the greatly increased productive capacity of the city, and the number of workpeople receiving Government assistance continues very high. The signs of the times are not favourable, and appear to indicate that the gulf between demand and capacity is widening rather than narrowing. This is particularly the case with the basic side of the heavy steel trade. It becomes increasingly difficult to find orders for the furnaces, and, unless some revival of demand comes about shortly, a further restriction of activities is probable. The acid steel furnaces, although not fully engaged, are much better off than the basic. Great quantities of their product are called for by the departments manufacturing railway axles, tires and springs. These departments continue steadily employed, although they could, if they had the opportunity, turn out almost twice as much material as they are now doing. The rolling mills also manage to run the greater part of their plant continuously.

Statistics of Production.

The figures of steel production during March show a falling off in every district of the country, the grand total being 652,300 tons, as compared with 816,900 tons in March last year. Sheffield's output of 94,000 tons represented a decline of 18,000 tons on the output of a year ago, and was also 3800 tons less than in February. The drop was chiefly in basic steel, of which only 38,300 tons were produced. The great change which has come about in the Lincolnshire trade is shown by the fact that the March figure, 33,100 tons, was 20,000 tons below that of twelve months ago. The figures of finished iron production are of a still more serious character. The bar iron trade is almost moribund at present, and merchants cannot recall a time when slackness was so pronounced.

Some Brighter Spots.

A more cheerful story comes from some of the finished steel departments than from the melting side. A fair amount of work continues to be placed with the steel foundries. The automobile trade has for a considerable time been a valuable customer for Sheffield material, and promises fully to maintain its position in that respect. There is also a good demand for Sheffield products from the electrical engineering industry. A really good trade is being done in farm tools, such as machine knives and scythes, and also parts of machinery used in connection with land cultivation. Some of the factories are finding it necessary to work overtime in order to cope with the demand, which is quite up to the average on home account, and above the average from the colonial markets. Makers of stove grates, sanitary fittings, light iron castings and other requirements of the building trade, are enjoying much activity.

Cutlery and Plate.

It is now becoming pretty clear that the 1925 output of cutlery will be much below the quantities of the two previous years. Although there are busy factories, such cases are quite exceptional, while those which are short of work form a large proportion of the whole. The falling-off in the demand for stainless cutlery is more and more noticeable, and the total quantity called for compares very badly with last year's. Little is being done in the pen and pocket knife departments, while the trade in the old-fashioned type of razors is in a very bad way. The spoon and fork trade is brisk, but for plated and silver hollowware there is not much demand. Some good special contracts are on hand, but the shop-keeping trade is flat, as many retailers are not in a financial position to maintain their customary stocks of expensive articles. The Government Departments are now allotting their annual contracts for plate and cutlery. A good deal of enterprise is being displayed by makers of cases to hold articles of cutlery and plate. They are constantly bringing out new designs, which are attractive and at the same time moderate in price.

Chinese Visitors.

Sheffield has this week been visited by an important Chinese mission, consisting of about twelve officials, headed by General S. T. Hsu, Envoy-Extraordinary of the Chinese Government, formerly Governor-General of Mongolia and Commander-in-Chief of the Army of the North-West, who is also a Chief Cabinet Secretary. The Mission, travelling under the auspices of the Board of Trade, has been entertained to dinner by the Chamber of Commerce, and has visited the works of Vickers, John Brown, Cammell Laird and Hadfields.

Nottinghamshire Coal Success.

Reference has been made several times to the rapid progress made with the sinking operations of the Firbeck Colliery, at Langold, near Worksop, which is a joint enterprise of the Sheepbridge and Staveley companies. Now comes the news that the work has been rewarded by the finding of a seam of coal, 5ft. 6in. thick. The colliery is situated in the midst of a number of successful pits, all of which work the valuable Barnsley bed. It is less than two years since sinking was begun, but a depth of over 800 yards has been attained. Water troubles have been encountered, but not of a very serious character. Some water was met with in the first 200 yards of the work, which was through limestone, and this was stopped by means of a concrete wall. Smooth progress was made for the next 250 yards, but at 450 yards water was again met with, pouring out of the strata at the rate of 75 gallons a minute. This necessitated a stoppage of the work in No. 1 shaft, in order that a pump might be put in and a lodge room dug between the two shafts. The water is collected in the lodge room, and from there pumped to the surface. The surface equipment of the colliery is practically complete. The winding engines, built by Messrs. Markham, of Chesterfield, have a spiral drum tapering down from a diameter of 28ft. to 16ft. The washery will deal with 160 tons of coal per hour.

A Hundred Years' Supply.

The information with regard to the developments of Messrs. J. and G. Wells, which I quoted last week, was supplemented by a statement made by the managing director of the company at the annual meeting. He said that at the Norwood Colliery, which had been deepened in recent years from 166 yards to 344 yards, they could look forward to a potential output of 500,000 tons per annum over a period of 100 years, while at the new Westthorpe sinking, an output of a similar tonnage over many years could be safely reckoned upon, given commercial adjustment of trade and markets.

Bio-aeration Progress.

The bio-aeration system of sewage treatment at the Sheffield Corporation works, of which Mr. J. Haworth, the general manager and chemist, is the inventor, is being gradually extended. For some time there have been five units in operation, each capable of purifying 1,250,000 gallons of sewage per day. Viscount Peel, the First Commissioner of Works, who visited Sheffield last week-end, opened a sixth unit, and eight more are to be constructed. When the scheme is complete, the works will be able to purify 17,500,000 gallons per day.

NORTH OF ENGLAND.

(From our own Correspondent.)

Steel Works to be Restarted.

AN interesting piece of news this week is the fact that steel making is to be recommenced at the Consett Iron Company's works a month hence. Two, out of a total of nine, steel furnaces will be started up. They will be worked purely as an experiment, but if trade conditions warrant it, the whole of the steel plant and rolling mills will be brought gradually into operation. Since the closing down of the steel furnaces two years ago, a reconstruction of the plant has been in progress, and this work, when finished about September this year, will, it is claimed, provide the company with the most up-to-date steel making plant in Great Britain and probably in Europe. There are already five hematite blast-furnaces in operation at the works. It is not unfitting that the Consett Company should be about to inaugurate a bold experiment, inasmuch as it is the second oldest steel making firm in Britain. It began to make steel in 1881, and until a few years ago its plant was considered efficient. But twenty to twenty-five years make a once modern steel plant obsolete, and accordingly a bold scheme of reconstruction has been carried through.

Cleveland Iron Trade.

Although little actual improvement can be reported in the position of the Cleveland pig iron trade, and while some of the works are still badly in need of orders, the feeling of pessimism is much less marked, and quotations are not quite so weak as they have been. As a rule, consumers continue to pursue a cautious policy owing to the uncertainty as regards the near future, but some little hope of returning confidence is encouraged by the fact that negotiations have resulted in one or two contracts being arranged for delivery a little way ahead. The opinion is gaining ground that establishment of stability in prices might be speedily followed by the release of a fair amount of business. The price of No. 3 G.M.B. Cleveland pig iron is steady at 76s. per ton for home use, but sixpence per ton more is asked for iron for export. No. 1 is 81s.; No. 4 foundry, 75s. 6d.; and No. 4 forge, 74s. 6d. per ton.

Hematite Pig Iron.

A fair amount of hematite has been sold during the past few days, but little impression seems to have been made on the stocks at makers' yards. Sellers are still asking 81s. per ton for East Coast mixed numbers, and 81s. 6d. per ton for No. 1 quality.

Ironmaking Materials.

The foreign ore trade is absolutely idle, and the freight market weak. In the absence of business, however, 22s. per ton c.i.f. Tees remains the nominal quotation for best Rubio ore. The stoppage of so many coke ovens in Durham has had the effect of more nearly balancing output and demand, and the price is somewhat firmer, 22s. 6d. per ton being now generally quoted for good furnace qualities delivered at the works.

Manufactured Iron and Steel.

There is a good deal more inquiry in the manufactured iron and steel trade, especially for semi-finished steel. Producers in this district are apparently endeavouring to compete with imported materials, but fair quantities of the latter are still arriving, though continental firms are less eager to sell at very low figures. There is an improved tone in the finsished steel section, and a number of overseas inquiries are reported. Steel ship-plates are now being sold as low as £8 15s. and steel sections at £8 7s. 6d.

The Coal Trade.

The Northern coal trade has once more assumed a very quiet aspect. The somewhat better demand for prompt supplies which was experienced a week or two ago has completely disappeared. Thus the position is appreciably worse. From all quarters demands are very light and consumers abroad take little interest in the position. Stocks at most centres are ample for weeks ahead, and with competition from every district, buyers show no anxiety, and only operate for small prompt quantities, while others hold off in the hope that prices will become lower. This, it is considered, is hardly likely to occur, as owners would rather close their pits than accept any reduction in prices. A good deal of interest is being taken in the inquiry of the Swedish State Railway administration for 200,000 tons of British or German steam coals to be shipped to the usual ports during June to September. Tenders are to be submitted on the 25th inst., and the competition is likely to be very keen. Northumberland steams for the whole of this month are stated to be fairly well placed with orders, and prices quoted are steady at 17s. 3d. to 17s. 6d. Tyne primes hold at 16s. 9d., but additional trade is badly needed. Steam smalls are steady for all qualities, as the output is curtailed by the lack of demand for screened kinds. Best Durham gas coal is in quiet demand, and freely available at 19s. 6d. There is no improvement to record in the demand for coke, and all makes, while easy in tone, are quoted steady, as makers are limiting production and holding steadily against any further concessions.

Coal Pit Reopened.

The work of reopening Pease and Partners' Bowden Close pit, near Willington, began this week. The pit has been idle ten months owing to a disagreement about working hours. The hewers have now agreed to work a seven hours' shift instead of a six and a-half hours' shift daily. There are to be two instead of three shifts of coal hewers.

SCOTLAND.

(From our own Correspondent.)

Acute Depression.

THE depression affecting practically all branches of industry is as acute as ever. For some time it was thought that the keen continental prices for competitive materials would ultimately assume a level in nearer relation to home values, and producers here maintained a fair measure of optimism. Time drags on, however, without bringing such alteration, and, in fact, latest advices point to even cheaper competitive prices. Therefore, it is unusual nowadays to hear the optimistic note, the tale on all sides being lack of business and the increasing difficulties in completing fresh contracts of even an extremely moderate nature. For some time past many producers in various industries have been selling or endeavouring to sell at prices which barely cover costs in order to keep plant in operation, but there must be a limit to such pro-

cedure. The result is inevitable, and may be seen in the closing of coal pits and the low or irregular measure of activity in existence in almost all other industries. Many expedients have been tried to induce business, but little success has attended these efforts so far, and at present the despondent note is uppermost.

Pig Iron.

Conditions ruling in the pig iron trade are unaltered. Home demands are weak, and shipments are small in bulk. Heavy stocks are held in makers' yards, despite a low measure of production, and prices continue weak. Hematite and foundry qualities are alike in this respect.

Steel.

There is little change either way in the steel trade. For immediate delivery there are some small inquiries in the market, but forward transactions are almost, if not wholly, unknown at present. Shipbuilding demands are meagre, and are not likely to increase for some time, in view of the lack of shipbuilding contracts of any kind. Few steel makers can see further than a week or so ahead. With prices free quotations now depend on the tonnage and class of specification involved, but it is said that the prices ruling are considerably below the old Association rates. Black sheets are now feeling a shortage of fresh business, and under keen competition prices are easing. Galvanised sheets are comparatively firm. Heavy steel scrap has been a shade busier, but this extra business is only momentary.

Bar Iron.

Bar iron producers still await the increase in business anticipated from the last cut in prices. Consumers adhere to their policy of buying only against immediate requirements, and orders are drastically curtailed. Re-rolled steel also is a difficult proposition at the moment. Prices are unchanged.

Coal.

The depression is perhaps more apparent in the coal trade than elsewhere. Nothing has occurred to lessen the gloomy aspect; in fact, the position apparently grows worse as time progresses. Home demands are weak, while export has almost reached vanishing point. Prices quoted for the latter do not appear to find favour, and in this connection it is rather disquieting to hear that German sellers have lowered their prices further, in view of reduced railway rates. Reports of Russian fuel for Italy also provide an unpalatable piece of news. At any rate, the home position is discouraging. Many pits are idle, and the number is constantly being added to. Accumulations of loaded wagons at pitheads tell their own tale. Collieries are only able to effect partial clearances by offering exceptionally keen prices. All fuels continue to ease, even the few descriptions which have been firm of late having reverted to the downward track. Our present trade with the Baltic is far below normal, and even our best customers, viz., Belgium and Italy, are only taking moderate cargoes. The home trade is equally disappointing. Aggregate shipments for the week amounted to 209,395 tons, against 256,204 tons in the preceding week and 271,861 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE conditions in the steam coal trade are undoubtedly better, and values are steadier. This might scarcely be credited, having regard to the fact that idle loading appliances are to be found at some of the docks, but the position is that it happens that the tonnage which is now being loaded, and is due to arrive, is, on the average, larger than that which has been available recently. It is not so long ago that merchants experienced the greatest difficulty in securing large tonnage, owing to its being spread abroad on a greater scale than usual. The result was that charterers not infrequently had to charter two small steamers to make up for one big one. Since then the big steamers have been making their way back to this country, and during the past week or so quite a number have been taken up to load coal cargoes outwards for South America and the Mediterranean. Most of the leading colliery undertakings have good stems on for the remainder of this month, and in some directions values have improved 3d. per ton. Exporters have found coals so tight that they have been unable to get the qualities they require for a week or ten days. It is quite refreshing to find this condition prevailing after such a long spell with excessive quantities of coals standing. The Portuguese State Railways recently bought 20,000 tons of large and small coals, and the Norte Railways of Spain have purchased about 20,000 tons of large coals for delivery during the next six weeks or so, while it is rumoured that there is a possibility of the French State Railways coming to this district for supplies before long, whereas during the past quarter they have been drawing upon the French collieries for their requirements. Apart from this, however, the general demand from abroad is still comparatively quiet, though there are hopes that the buying will shortly display expansion.

Tin-plate Trade.

Reference was made last week to the break up of the scheme for the stabilisation of prices, and to the fact that a free market now existed, but it was pointed out that hopes were entertained that sections of the scheme might be retained. It should be stated, however, that suspension of the scheme, *sine die*, applied not only to the prices part of the arrangement, but also to pooling of orders. The question as to the probable effect of the development upon wages has been raised. The fall in the price of steel bars and the reduced prices obtained for tin-plates, as the result of the competition prevailing, will undoubtedly have an adverse effect upon wages eventually, though the present ascertainment is in operation until August 1st. The annual meeting of the workmen's section of the Tin-plate Joint Industrial Council was held at Swansea this week, and matters affecting the trade were discussed in private, one of the subjects being the collapse of the stabilisation scheme. It is understood that several definite proposals were formulated for submission to the annual joint meeting, the date of which has to be fixed. It is evident that the workmen's leaders feel annoyed at the termination of the stabilisation scheme, and the fact that the manufacturers ignored labour in the matter.

Steam Colliery Deal.

Although no official confirmation is forthcoming at the moment, it is understood that negotiations have reached a final stage for the acquisition of the Windsor Colliery in the Aber Valley by the Powell Duffryn Steam Coal Company. What the conditions of transfer are have not been disclosed. The Windsor Colliery is owned by the Windsor Steam Coal Company (1901), Ltd., and has a mineral area of about 3000 acres. Some little time ago the workmen were informed that, unless a change was made in the working conditions, the colliery would have to be closed down.

Salvage Success.

On Friday last the ss. Pilton, a steamer of 5060 tons, was successfully refloated. The operation aroused very considerable interest in this district, and was a notable achievement on the part of Mr. J. Hindmarsh, the managing director of the Cornish Salvage Company, which took on the task on the basis of "no cure, no pay." This steamer went ashore between Sully and Swanbridge at the end of last December during a gale. The most difficult part of the task of moving her from her high position on the rocky foreshore was accomplished about three weeks ago, when the vessel was moved sufficiently far towards the sea to ensure her taking the water on the next spring tide. Eleven launching ways of timber had been constructed with concrete foundations to support the vessel, which, by means of stout wedges, had also been raised about a foot in order to carry the slipways underneath, and to put the sliding blocks in position. The steamer has since been placed in the Barry graving dock for examination.

Current Business.

The tone of the steam coal market has shown marked improvement during the past week. Most of the best Admiralty large coals and second qualities are well stemmed for the remainder of this month, while Monmouthshire descriptions are well placed for prompt loading. Some of the collieries are quoting a shade higher prices, and are fairly confident of maintaining them, especially as, during the first week of June, there will be a curtailment of output, owing to the holidays. Small coals continue steady in the case of superior qualities, while patent fuel remains without change. Anthracite coals are rather scarce, except so far as beans and duff coals are concerned. Other descriptions are firm.

LAUNCHES AND TRIAL TRIPS.

COMORIN, twin-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of the Peninsular and Oriental Steam Navigation Company, Ltd.; dimensions, 545ft. by 70ft. by 46ft.; 15,000 gross tonnage. Engines, twin-screw quadruple-expansion, pressure 220 lb.; constructed by the builders; trial trip, April 11th.

SHIRLEY G. TAYLOR, steamer; built by Earle's Shipbuilding and Engineering Company, Ltd.; to the order of the Eastern Steamship Company, Ltd.; dimensions, 258ft. by 44ft. by 20ft.; 2510 tons deadweight. Engines, triple-expansion, surface-condensing, 17in., 28in. and 46in. by 33in. stroke, pressure 180 lb.; constructed by the builders; trial trip, April 11th.

SHELTON WEED, steamer; built by Earle's Shipbuilding and Engineering Company, Ltd., to the order of the Eastern Steamship Company, Limited; dimensions, 258ft. by 44ft. by 20ft.; 2510 tons deadweight. Engines, triple-expansion, surface condensing, 17in., 28in., 46in. by 33in. stroke, pressure 180 lb.; constructed by the builders; launch, April 15th.

INVERCAIBO, twin-screw oil vessel; built by Harland and Wolff, Ltd., to the order of Andrew Weir and Co., for the Lago Shipping Company, Ltd.; dimensions, 315ft. long by 50ft. beam; 2360 gross tonnage. Engines, twin-screw triple-expansion; constructed by the builders; launch, April 23rd.

ELMBANK, motor ship; built by Harland and Wolff, Ltd., to the order of Andrew Weir and Co.; dimensions, 434ft. by 53ft. 9in. by 37ft.; 5200 gross tonnage. Engines, two sets of Harland and Wolff B. and W. motors; constructed by the builders; launch, recently.

ERRINGTON COURT, steamer; built by Workman, Clark and Co., Ltd., to the order of Haldin and Co.; dimensions, 410ft. long; 4900 gross tonnage. Engines, single-screw, vertical inverted, direct-acting, surface condensing, triple-expansion; constructed by the builders; launch, April 23rd.

CITY OF KIMBERLEY, steamer; built by Wm. Gray and Co., Ltd., to the order of the Ellerman Lines, Ltd.; dimensions, 433ft. by 58ft. 3in. by 32ft. 8in. Engines, triple-expansion, 24½in., 42½in., 74in. diameter by 51in. stroke; constructed by the builders; trial trip, April 24th.

CALENDARS, DIARIES, &c.

WM. BEARDMORE AND CO., Ltd., Glasgow.—Calendar, May, 1925, to April, 1926, two months to a page. Six pictures have been attached to the sheets, giving illustrations of some of the activities of the company.

THE HARLAND ENGINEERING COMPANY, Ltd., associated with the British Electric Plant Company, Ltd., Manchester and Alloa, Scotland.—Wall calendar from March, 1925, to February, 1927. The subject of the calendar is "Pumping Problems Solved."

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester.—Annual wall calendar, with monthly tear-off sheets.

CATALOGUES.

DERWENT FOUNDRY COMPANY (1920), Ld., Derby.—Booklet illustrating and describing the "Unicum" die.

SIEMENS BROTHERS AND CO., Ld., Woolwich.—Pamphlet 720 A, entitled "Mine Shaft Signalling Apparatus."

BARIMAR, Ld., 14-18, Lamb's Conduit-street, W.C. 1.—Booklet dealing with the Barimar metallurgical process for repairing aluminium parts.

JAMES KEITH AND BLACKMAN COMPANY, Ld., 27, Farringdon-avenue, E.C. 4.—Leaflet describing the Keith-Blackman wood refuse removal plant.

RANSOME MACHINERY COMPANY (1920), Ld., 14-16, Grosvenor-gardens, S.W. 1.—Catalogue No. 38, entitled "The F.H. Patent Concrete Discharging Skip."

DELCO-REMY AND HYATT, Ld., 56, Victoria-street, S.W. 1.—Loose leaves 1 to 16A, I N 32 to I N 3J showing altered prices which supersede those previously issued.

HIGGS BROTHERS, Witton, Birmingham.—Stock list of motors and dynamos, the prices of which have been reduced.—Also price list No. 10, of motors and dynamos.

HERBERT MORRIS, Ld., Loughborough.—Book 83, dealing with light overhead electric travelling cranes. Book 84, illustrating and describing Morris pulley blocks.

CLAYTON AND SHUTTLEWORTH, Ld., Stamp End Works, Lincoln.—Binder containing a number of booklets illustrating and describing various "Clayton" manufactures.

GRAZIANI AND CO., Ld., 110, Fenchurch-street, E.C. 3.—Catalogue illustrating and describing the works and manufactures of Ansaldo S.A., Genoa, for whom they are agents.

DOWDING'S MACHINE TOOL COMPANY, Bush House, Aldwych, W.C. 2.—Leaflet illustrating the "Stringertype" surface grinder.—Also price list of second-hand gear-cutting machines and a card illustrating the Zeiss passameter.

THE MIRRLEES-WATSON COMPANY, Ld., Scotland-street, Glasgow.—Publication No. S. 80, illustrating and describing "The Searby Shredder System of Milling Sugar Cane."—Also publication No. S. 300, illustrating and describing the "Mirrlees" multiple effect evaporators.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Ld., Falcon Works, Loughborough. Publication No. 3011, entitled "Bus Bodies," illustrating and describing some of the vehicles manufactured during 1924.—Also publication No. 0001, entitled "The Works of the Brush Electrical Engineering Company."

ROYAL SOCIETY OF ARTS: FOTHERGILL PRIZE.—Under the Fothergill Trust the Council of the Royal Society of Arts offers a prize of £100 for an essay on "Fire Waste (Loss of Property by Fire) and its Effects on the Economics of National Life in Great Britain." Intending competitors must send in their essays not later than July 31st, 1926, to the Secretary, Royal Society of Arts, John-street, Adelphi, London, W.C. 2, from whom further particulars may be obtained.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—The Council of the Institution of Electrical Engineers has made the following awards of premiums for papers read during the session 1924–25, or accepted for publication:—The Institution Premium to Mr. H. W. Clothier; Ayrton Premium to Major E. I. David; Fahie Premium to Colonel T. F. Purves; John Hopkinson Premium to Mr. G. Rogers; Kelvin Premium to Lieutenant-Colonel K. G. Maxwell and Mr. A. Monkhouse; Paris Premium to Mr. D. Murray; Extra Premiums to Messrs. J. D. Cockcroft, R. T. Coe, J. A. Tyacke and Professor Miles Walker, D.Sc., and Mr. S. Holmes; Wireless Premiums to Major A. G. Lee, M.C., and Mr. A. J. Gill, Captain H. J. Round, M.C., and Messrs. T. L. Eckersley, K. Tremellen, and F. C. Lunnon, Professor E. Mallett, M.Sc., and Mr. A. D. Blumlein, and Mr. L. C. Pocock.

DROP-STAMPED RAILWAY WHEELS.—In our issue of July 18th, 1924, we described the huge drop stamp which was made by Brett's Patent Lifter Company for Powell-Brett, Ltd., and illustrated the new form of wheel which is being produced by it. It will interest our readers to know that the latter firm has obtained a contract from the India Office for the North-Western Railway of India for drop-forged wheels in substitution of the chilled cast iron type. These wheels are forged in a B.E.S.A. standard "B" steel for tires. They are 20in. diameter on the tread and the boss is 7¼in. diameter by 4¼in. thick. Four bulges or panels in the web increase the stiffness of the wheel without augmenting the weight. We understand that it is the intention to put these wheels into service without machining the tread, and it is anticipated that the wearing effect will be exceptionally good, because of the intensive hammering to which the steel has been subjected. The skin produced by the highly finished dies is very hard. The wheels are being inspected by Messrs. Rendel, Palmer and Tritton.

CRYSTAL PALACE OLD STUDENTS' SOCIETY ANNUAL DINNER.—Sir Charles Langridge Morgan, being an honorary member of the Crystal Palace Old Students' Society, was guest of the evening at a dinner held at the Criterion Restaurant on May 6th. Mr. V. A. M. Robertson, of the London and North-Eastern Railway, president, was in the chair, while among the members present were Sir Cyril Kirkpatrick, Mr. W. C. Sandberg, Mr. J. W. Wilson, of the Crystal Palace School, and many other engineers whose names are well known. This was the twenty-fourth annual dinner of the society, the objects of which are the promotion of good fellowship between old Students of the Crystal Palace School of Practical Engineering, and the assistance of younger members, entering the profession. Particular attention was drawn by more than one speaker at the dinner to the great importance of younger members being properly qualified by becoming associate members of the Institution of Civil Engineers. The supply of properly qualified junior engineers appeared to be less than the demand. A complete revision of the school course of training had recently been made in order that the right type of man with the right qualification should be forthcoming.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon (May 4th), Sir James Crichton-Browne, treasurer and vice-president, in the chair. It was announced that the president, the Duke of Northumberland, had nominated Sir Thomas Barlow, Sir Dugald Clerk, Earl Iveagh, Sir Ernest Moon, the Hon. Sir Charles Parsons, Sir Edward Pollock, Sir James Crichton-Browne, and Sir Arthur Keith, as vice-presidents for the ensuing year. Sir J. J. Thomson was re-elected Honorary Professor and Sir Ernest Rutherford Professor of Natural Philosophy. The chairman reported the death of Sir David Salomons, a former vice-president and manager, and a resolution of condolence with Lady Salomons and the family was passed. Mr. H. Wynne-Finch, Mr. W. McLellan, Mr. H. A. Ottewill, Mr. T. H. O. Richardson, Dr. Godfrey Rotter, Mr. R. S. Whipple and Mr. R. P. Wilson were elected members.—The Tyndall Lectures will be delivered this year by Professor R. Whiddington, on "The Passage of Electricity through Vacuum Tubes," commencing on Tuesday, May 19th, at 5.15 p.m. The Friday evening discourse on May 22nd will be delivered by Dr. Thorne M. Carpenter, of the Carnegie Nutrition Laboratory, on "The Metabolism of Men and Animals," and on May 29th by Sir Henry Newbolt on "Scenery in the Pastoral Poets." Sir William Pope will give an extra discourse on June 12th on "Faraday as a Chemist."

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	20/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 10 6	—
No. 1 Foundry	4 8 6	—
No. 3 Foundry	4 6 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 1 0	4 1 0
No. 1	4 1 6	4 1 6
Cleveland—		
No. 1	4 1 0	4 1 0
Silicious Iron	4 1 0	4 1 0
No. 3 G.M.B.	3 16 0	3 16 6
No. 4 Foundry	3 15 6	3 15 6
No. 4 Forge	3 14 6	3 14 6
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 10 0 to 3 12 6	
,, Forge	3 6 0 to 3 7 0	
(3) Derbyshire—		
No. 3 Foundry	3 15 0 to 3 16 0	
Forge	3 10 0 to 3 12 0	
(3) Lincolnshire—		
No. 3 Foundry	4 0 0	—
No. 4 Forge	3 15 0	—
Basic	3 15 0	—
(4) N.W. COAST— N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 13 0 (a); 4 16 0 (b); 5 1 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 12 6	—
Best ,,	—	—
N.E. COAST—		
Common Bars	11 12 6	—
LANCS.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 10 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 10 0	—
Ship Plates, ½in. and up	8 17 6	—
Sections	8 7 6	—
Steel Sheets, under 3/16in. to ½in.	10 5 0 to 10 10 0	
Sheets (Gal. Cor. 24 B.G.)	—	17 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	—
Angles	8 7 6	—
Boiler Plates	13 0 0	—
Joists	8 7 6	—
Heavy Rails	8 15 0	—
Fish-plates	12 15 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 15 0†	—
Light ,,	9 0 0 to 9 5 0	
Billets	8 0 0 to 11 0 0†	
MANCHESTER—		
Bars (Round)	9 0 0 to 10 0 0	
,, (others)	8 15 0 to 9 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	9 5 0	—
,, (Lancs. Boiler)	12 10 0	—
SHEFFIELD—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
MIDLANDS—		
Small Rolled Bars	8 15 0 to 9 15 0	
Billets and Sheet-bars	6 17 6 to 7 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 10 0 to 16 15 0	
Angles	8 10 0 to 8 15 0	
Joists	8 10 0 to 8 15 0	
Tees	9 10 0 to 9 15 0	
Bridge and Tank Plates	9 5 0 to 9 10 0	
Boiler Plates	13 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/6 to 21/-
Block Tin (cash)	242 15 0
,, (three months)	244 15 0
Copper (cash)	60 5 0
,, (three months)	61 2 6
Spanish Lead (cash)	32 13 9
,, (three months)	32 3 9
Spelter (cash)	34 7 6
,, (three months)	33 11 3
MANCHESTER—	
Copper, Best Selected Ingots	63 10 0
,, Electrolytic	64 10 0
,, Strong Sheets	60 0 0
,, Tubes (Basis Price)	‡ 0 1 1
Brass Tubes (Basis price)	‡ 0 0 11½
,, Condenser	‡ 0 1 2
Lead, English	35 0 0
,, Foreign	33 15 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 5 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£43 0 0	15/6
,, ,, 1 p.c. ,,	£52 0 0	17/-
,, ,, 0.70 p.c. carbon	£57 10 0	19/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 15 0	scale 5/- per unit
,, ,, 75 p.c.	£22 10 0	scale 6/- per unit
,, Vanadium	17/- per lb	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/- per lb	
Nickel (per ton)	£175	
Cobalt	10/3 per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	15/-
,, ,, Ell	15/9
,, ,, Splint	16/9 to 19/-
,, ,, Trebles	14/6
,, ,, Doubles	13/6
,, ,, Singles	13/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	15/-
,, ,, Splints	16/9
,, ,, Trebles	14/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/9 to 16/-
Screened Navigation	21/6
Trebles	15/9 to 16/-
Doubles	13/-
Singles	12/9
LOTHIANS—	
(f.o.b. Leith)—Best Steam	15/9
Secondary Steam	15/1½
Trebles	16/-
Doubles	13/6
Singles	13/-

ENGLAND.

(8) N.W. COAST—	
Steams	27/-
Household	45/- to 58/4
Coke	28/-
NORTHUMBERLAND—	
Best Steams	17/3 to 17/6
Second Steams	16/6
Steam Smalls	11/- to 11/6
Unscreened	15/6 to 16/6
Household	23/6 to 25/-
DURHAM—	
Best Gas	19/6 to 19/9
Second	17/- to 17/3
Household	23/6 to 25/-
Foundry Coke	21/6 to 22/6
SHEFFIELD—	Inland.
Best Hand-picked Branch	30/- to 33/- —
Barnsley Best Silkstone	26/- to 27/- —
Derbyshire Best Brights	26/- to 28/6 —
,, ,, House	23/6 to 25/6 —
,, ,, Large Nuts	18/- to 22/- —
,, ,, Small	14/- to 16/- —
Yorkshire Hards	18/- to 22/- —
Derbyshire ,,	18/6 to 22/- —
Rough Slacks	10/- to 12/6 —
Nutty ,,	8/6 to 10/- —
Smalls	3/6 to 5/6 —
Blast-furnace Coke (Inland)*	— —
,, ,, (Export)	f.o.b. 21/3 to 22/3

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	26/- to 26/9
Second ,, ,,	25/3 to 26/-
Best Dry Large	25/- to 25/6
Ordinary Dry Large	23/6 to 24/6
Best Black Vein Large	24/6 to 25/-
Western Valley ,,	23/6 to 24/6
Best Eastern Valley Large	23/- to 24/-
Ordinary ,, ,,	22/6 to 23/-
Best Steam Smalls	15/6 to 16/-
Ordinary ,,	13/- to 15/-
Washed Nuts	20/- to 27/6
No. 3 Rhondda Large	27/- to 27/6
,, ,, Smalls	17/- to 18/-
No. 2 ,, Large	22/- to 23/-
,, ,, Through	18/- to 20/-
,, ,, Smalls	12/- to 13/6
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	25/- to 30/-
Patent Fuel	23/- to 26/-
Pitwood (ex ship)	22/6 to 23/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	44/- to 46/-
Seconds	38/- to 40/-
Red Vein	29/- to 32/-
Machine-made Cobbles	52/6 to 57/6
Nuts	50/- to 55/-
Beans	37/6 to 41/6
Peas	22/6 to 23/6
Breaker Duff	8/6 to 8/9
Rubbly Culm	1/- to 13/6
Steam Coals:	
Large	21/- to 24/-
Seconds	20/- to 21/-
Smalls	10/- to 13/-
Cargo Through	16/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/9, with fluctuations according to analysis; open market, 18/- to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

‡ A reduction may come this week.

French Engineering Notes.

(From our Correspondent in Paris.)

Trade Exchanges.

THE wave of Protection which has spread over Europe of late years is not due solely to the immediate necessities of home industries. The suppression of the old treaties of commerce left many countries without defence in negotiating for treaties to replace them, and it became difficult to practice reciprocity when the development of new industries created competition where formerly there was an interchange of goods. The first striking instance of the change produced by the economic new situation was the refusal of the Belgian Chamber of Deputies to ratify the provisional treaty of commerce which had been entered into with France after long and tedious negotiations. The Belgians found that, being then bound by a Free Trade policy, they were giving too much for very little offered by France. Their hands were forced because they could not stand out for reciprocity. The proposed treaty was rejected, and a particularly severe Tariff Bill was adopted ostensibly with the idea of strengthening the hands of the Belgians in future negotiations. The tariffs struck with special force at French products, and yet the French showed less receptment towards this swing of the pendulum from Free Trade to Protection than they are now displaying towards the new British duties, which, however, apply only to a few productions. The effect of the high Belgian duties has been the preparation of a new provisional treaty much more favourable to Belgian industries. High duties are therefore regarded as necessary to negotiation, especially in view of the fact that the separate treaties carried out nowadays are intended to facilitate the export of certain classes of goods to particular markets and, more than ever before, political considerations influence the character of the concessions granted. The blow to some of the French industries by the McKenna duties will almost certainly hasten a change in international trade conditions, which may eventually result in a return to more normal state of things.

Reparations.

The objections being raised against the importation of manufactured goods from Germany on account of reparations show that home firms are fully alive to the danger of pursuing a policy that will inevitably encourage future competition. At the time the Government decided to secure for reparation as much as possible in the form of raw material and manufactured goods, it was stated that nothing would be done without consulting the home industries interested, and that, in any case, an equivalent weight of orders would be distributed amongst French makers. The works were then sufficiently employed to warrant the belief that goods could be imported from Germany without seriously prejudicing the situation of home firms. Since then the situation has changed for the worse, and orders in all branches of the metallurgical and engineering trades are very restricted, with the result that the threatened increased importation from Germany has become a matter for serious consideration. The various Chambers of Commerce are pointing out that the placing of orders in Germany for goods on account of reparations is not only depriving French firms of work at a time when it is most urgently needed, but that the displacement of activity to German factories will enable them to increase their production considerably and place them in a better position to extend their business in foreign markets. The representatives of the French industrial interests therefore urge that reparations should be restricted to raw material, and that no manufactured goods should be obtained from Germany so long as there is a lack of work in corresponding home industries. The Government argues that railway rolling stock and other material are being ordered from Germany for reparation because the financial situation will not allow of the purchases being effected in France. This argument naturally fails to convince home manufacturers.

The Makhonine Motor Fuel.

Since the trials of the Makhonine apparatus for producing motor spirit direct from crude oils were carried out at Vincennes by a military commission, with results that were declared to be highly satisfactory, nothing further has been done to confirm those results, despite the offers that have been repeatedly made to the inventor to subject the apparatus to official and scientific tests. The committee of the Société des Ingénieurs Civils de France, which was appointed to investigate synthetic fuels, has secured from the War Ministry a loan of the apparatus to carry out tests on condition of the necessary sanction being obtained from the inventor. It was proposed to test the apparatus in the laboratory of the Automobile Club de France, which is certainly the best equipped for the purpose. Meanwhile, M. Makhonine had entrusted the Office National des Combustibles Liquides with the task of carrying out the tests, and the fuel committee of the Société des Ingénieurs Civils is now negotiating with that body to experiment with the apparatus in collaboration, preferably in the laboratory of the A.C.F. It appears that arrangements are now well advanced and that the trials will be carried out in the presence of an influential commission composed of eminent scientists and engineers interested in the fuel problem. This will doubtless settle once and for all the controversy that has been waged for some time past over the results claimed to have been obtained, it being argued that the military tests were not sufficiently conclusive, and that the Makhonine process could not be accepted as capable of doing all that was claimed for it until the results were verified independently by scientific tests. At the same time experiments will be made with the new spirit "iroline," for which remarkable results are claimed by its inventor, M. Laurent. The fuel to be used in the tests will be produced in the presence of M. Berthelot.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

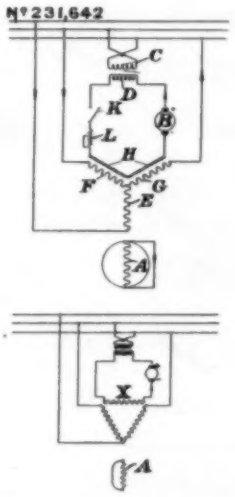
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

231,642. March 3rd, 1924.—IMPROVEMENTS IN AND RELATING TO SYNCHRONOUS ELECTRIC MACHINES, Claudius Shenfer, St. Basmannaja-street 15, Moscow, and the English Electric Company, Ltd., Queen's House, Kingsway, London.

This invention relates to alternating-current electric machines of the synchronous type. Energy is fed to the primary element of synchronous machine, which is provided with short-circuited single-phase rotor winding A. An exciter is shown at B, and a transformer which has primary winding C and secondary winding D. The stator phases E F G are star connected, and joined to the mains. A separate direct-current exciting winding H is provided, and it may conveniently be wound in the same slots as phases F and G. Winding H is connected in series with the exciter B, the secondary D of the transformer switch K and a regulating resistance L. In the lower diagram the stator phases are connected in open delta, the two free ends being separately joined to two mains, and the common point being joined to the remain-

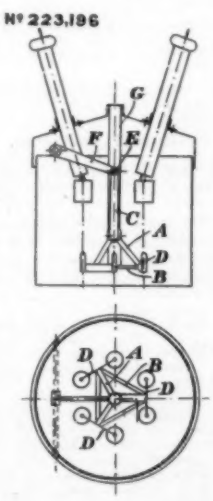


ing main. The third stator phase X is utilised as a direct-current winding, and is joined in series with the exciter and secondary winding of the transformer. In general, it is most convenient to connect the primary winding of the transformer with an appropriate pair of the alternating-current mains, provision being made for ensuring the correct value and phase of the electromotive force induced in the secondary winding of the transformer. When starting a machine of this kind working as a motor, the rotor runs up to a speed approximately one-half that which it would have when running synchronously with a three-phase winding on both rotor and stator. The field H or X may then be excited, whereupon the macine pulls into step, and runs at a constant speed. As the electromotive force induced in the secondary of the transformer and that induced in the direct-current field winding are of equal value and frequency, and are in phase opposition, the current flowing in the exciter circuit does not pulsate, and is substantially a continuous and constant current.—*April 9th*, 1925.

SWITCHGEAR.

223,196. August 8th, 1924.—IMPROVEMENTS IN OR RELATING TO OIL BREAK SWITCHES. Sachsenwerk Licht-und Kraft Aktiengesellschaft, of Niedersedlitz, near Dresden, Germany.

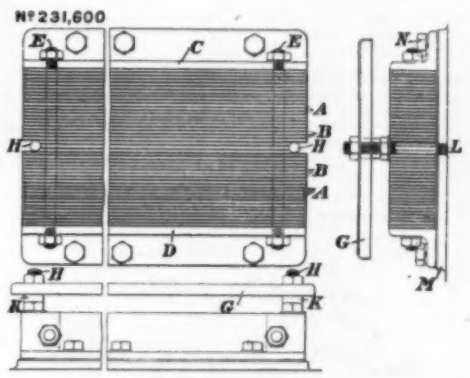
The type of switch to which this invention mainly relates is



the multipolar form, with an oil tank, consisting of a single chamber, and the object of the invention is to provide an improved switch of this kind suitable for high voltages. The contact-carrying cross-arm or traverse consists of insulating tubes A arranged to form a pyramid, and they are joined to one another by stiffening bars B. The contact blades D are fastened to the insulating tubes A. The cross-arm or traverse is fastened to a lever F by bars C and a bolt E. The bars C or the current-carrying traverse can be guided by a guide tube G in any suitable manner, and the stiffening bars B can be arranged so as to form an equilateral triangle, as shown in the plan.—*April 9th*, 1925.

231,600. January 10th, 1924.—IMPROVEMENTS IN EXPLOSION-PROOF CLOSURES FOR ELECTRICAL APPARATUS, Allen West and Co., Ltd., and Allen West, both of Lewes-road, Brighton, in the county of Sussex.

Electrical apparatus, such as motor starters, rheostats, &c., for use in mines have to be enclosed in explosion-proof housings, and the method generally adopted of rendering the housings explosion proof is to provide a vent of sufficient length and area so that any explosive pressures are relieved, the hot gases passing along a vent path sufficiently long to ensure that they are cooled before they reach the atmosphere and of sufficient area to ensure the necessary fall in pressure within the housings. The invention has for its object to provide means whereby the necessary length and area of vent path are ensured. The vent device may be constructed as a separate unit, or it may be formed as a cover for the housing. A number of plates of metal A A are

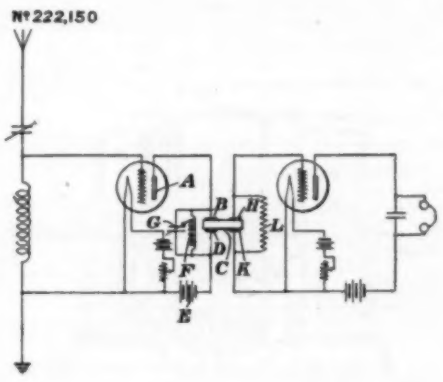


separated from one another at their ends by washers or distance pieces B B of the thickness equal to that of the desired vent space between the plates, the number and thickness of these sheets for any particular apparatus varying with the total vent area desired. The vent cover is built up of upper and lower cover-securing members consisting of angle bars C and D between which the plates A A are held, and the washers B B are held by means of bolts E passing through them. In front of the vent cover and at a distance necessary to give the desired free exit for air or gases passing from the electrical apparatus, a plate or outer cover G is fixed and is held in position at each end by a stud H and nut, on which is threaded a distance bush K and nut and washer. The lower end of the stud H passes through the plates A and washers B, and its projecting end L is screwed into the housing M of the switch. The vent cover is held on the housing by means of screws N, a washer being arranged between the vent cover and the housing.—*April 9th*, 1925.

TELEGRAPHS AND TELEPHONES.

222,150. September 22nd, 1924.—IMPROVEMENTS RELATING TO RECEIVING SYSTEMS FOR ELECTRIC SIGNALS, *Metropolitan-Vickers Electrical Company, Ltd., of 4, Central-buildings, Westminster.*

One object of this invention is to provide a wireless receiving system having great selectivity, whereby the tuning of the system is greatly simplified. The anode A of the first valve is connected to a plate B that is cemented to one side face of a piezo-electric crystal C. The opposite side face of the crystal has a plate D, similarly secured thereto. The plate D is connected to a battery E, whereby the crystal C is inserted in the plate circuit of the first valve. An inductance coil F is con-



nected across the crystal to afford a conductive path for the current from battery E. If desired, a condenser G is provided in parallel with the inductance coil F, so that the two together form a tuned circuit. The potentials impressed on the plates B and C will then be increased by the resonant action of this circuit. Two plates H and K are also connected to the two side faces of the crystal, but are separated from the other plates. These plates are in the grid circuit of a second valve, and to furnish a grid leak a high resistance element L is connected around the crystal. This second valve may be connected in any of the usual circuits employed in a receiving system.—*April 7th*, 1925.

MEASURING AND TESTING INSTRUMENTS.

231,708. June 20th, 1924.—BOURDON PRESSURE GAUGES, R. A. Hopkinson, P. G. Hopkinson, and J. Hopkinson and Co., Ltd., Britannia Works, Huddersfield.

This invention relates to Bourdon type pressure gauges, and has for its object to provide improved means for securing the end of the flattened expansion tube to the tube holder, the said means being unaffected by high temperatures and not deteriorating in service. The end of the flattened tube is swelled out to

a circular section, as shown at A, and is also bell-mouthed on the inside of the holder fitting. A plug B is then screwed into the fitting to hold the tube in place and make a tight joint. It

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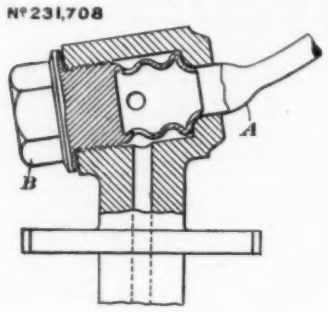

will be noticed that the hollow part of the plug is corrugated, so that it beds down properly on the tube and on the flange.—*April 9th*, 1925.

231,407. January 10th, 1925.—THEODOLITES, C. F. Casella and Co., 49–50, Parliament-street, Westminster, and R. M. Abraham.

The object of this invention is to facilitate the simultaneous reading of the divisions of the horizontal circle of a theodolite on opposite sides of the diameter. For this reason, the scale A

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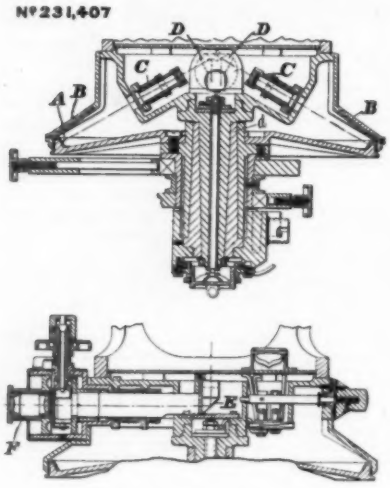


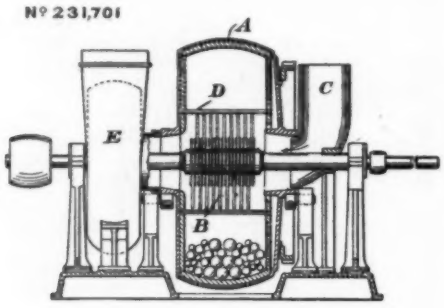
is arranged obliquely, is illuminated through windows B B, and is viewed through two microscopes C C. The light from these microscopes is reflected by two prisms D D at the axis, on to another prism E, which is observed through the eyepiece F. It is suggested in the specification that the system may be elaborated for reading the scale at more than two points simultaneously.—*April 2nd*, 1925.

CRUSHING AND GRINDING.

231,701. June 4th, 1924.—BALL MILLS, J. P. van Gelder, 200, William-street, Granville, near Sydney, New South Wales.

This grinding mill is of the compound type, in which the material is first broken up by beaters and is then fine-ground by balls. It comprises an outer shell A carried by roller bearings and rotated at a comparatively slow speed. Within it there is a

No 231,701



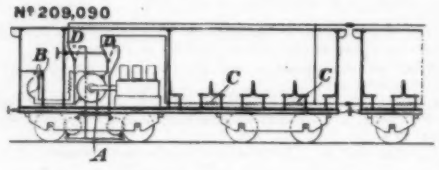
set of beaters B driven at a relatively high speed. The material is fed into the shoot C and is first acted on by the beaters, which throw the particles against the anvil bars D. The stuff then escapes between these bars, and, falling into the outer drum, is ground very finely by the balls. The fine material is aspirated by the fan E.—*April 9th*, 1925.

LOCOMOTIVES.

209,090. December 27th, 1923.—IMPROVEMENTS IN OR RELATING TO LOCOMOTIVES AND OTHER VEHICLES HAVING COMBINED INTERNAL COMBUSTION AND ELECTRIC PROPULSIVE SYSTEMS, *Bertram Edmund Dunbar Kilburn, of Chancery-lane Chambers, High Holborn, W.C.*

According to this invention, electrical energy when not required for propulsion purposes is utilised to assist in the heating of the locomotive or tractor unit or of the trailing cars. The coach shown in the drawing is provided with motors, as shown, and they are supplied with current from a generator A driven by a Diesel engine. The controller is shown at B and electric heaters at C. By means of the switch D the generator A can either be connected to the axle motors or to the heating devices. On a level stretch of track or on an up gradient the generator is connected to the driving motors, and under these conditions the engine will produce a considerable amount of heat in the exhaust, which is transferred to the hot water heating system.

No 209,090



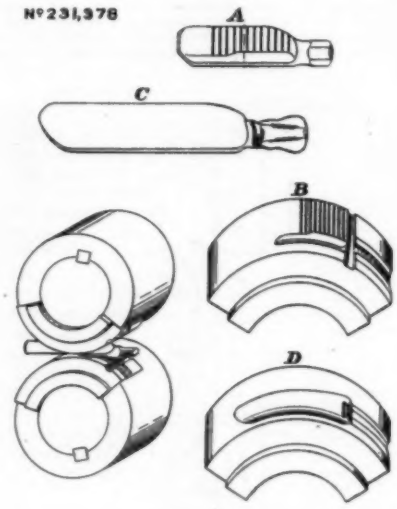
But when the vehicle is running on down gradients, or when it is stationary, the generator is connected to the electrical heating devices.—*December 27th*, 1923.

MISCELLANEOUS.

231,378. July 30th, 1924.—MAKING KNIFE BLADES, *E. C. R. Marks*, 57–58, *Lincoln's Inn-fields, London, W.C.* 2.

This process of rolling knife blades is intended to eliminate the longitudinal curvature produced in the ordinary process on account of the greater relative extension of the thin edge, as compared with the thick edge. A slug A is rolled, from a plain blank, by means of segmental rolling dies, one of which is shown at B. The slug is formed with transverse ribs, which make the metal flow sideways, rather than endways, and has an excess of metal on the side which will make the thick edge. The slug is

No 231,378



then rolled to the finished form C by segmental rolls D, and in the process the excess metal adjacent the thick edge of the slug is crowded along with the thick edge of the slug and builds on to or lengthens the thick edge in compensation for the natural differential elongation of the thick and thin edges. The differential elongation of the thick and thin edges being compensated for by just enough metal at the thick edge to lengthen it to the same extent that the thin edge is lengthened, the blade rolls out straight, and ready for the succeeding trimming, grinding and polishing operations.—*April 2nd*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Recent Developments in Magnetism," by Professor C. G. Darwin. 9 p.m.

WEST BROMWICH ENGINEERING SOCIETY: RADIO SECTION.—The Technical School, West Bromwich. Lecture, "Radio Valves," by Mr. R. C. Clinker. 7.30 p.m.

TO-DAY AND SATURDAY, MAY 16TH.

INSTITUTE OF TRANSPORT.—Congress in London. For programme, see page 473.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Irish District meeting at Dublin.

SATURDAY, MAY 16TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Visit to the works of Leyland Motors, Ltd., Leyland, near Preston. 3 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Western District meeting at Tiverton. 11 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Wath-upon-Dearne. Yorkshire District meeting. 10 a.m.

SATURDAY TO SATURDAY, MAY 16TH TO 30TH.

SEVENTH INTERNATIONAL PRINTING, STATIONERY AND ALLIED TRADES EXHIBITION.—Royal Agricultural Hall, Islington, London, N. 1.

MONDAY, MAY 18TH.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—Storey's-gate, Westminster, London, S.W. 1. Annual meeting. "Some Factors in the Choice of the Best System of Traction for Handling Dense Suburban Rail Traffic," by Mr. P. W. Thomas. 7 p.m.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.—9, Conduit-street, Hanover-square, London, W 1. Lecture, "The Architectural Development of American Cities," by Mr. G. Topham Forrest. 8 p.m.

TUESDAY, MAY 19TH.

ILLUMINATING ENGINEERING SOCIETY.—Lighting Service Bureau, 15, Savoy-street, Strand, London, W.C. 2. Paper, "A Survey of Lighting in 800 Retail Shops," by Messrs. W. J. Jones and H. Lingard. 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Passage of Electricity through Vacuum Tubes (I.)," by Professor R. Whiddington. 5.15 p.m.

WEDNESDAY, MAY 20TH.

INSTITUTION OF PRODUCTION ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Mechanical Costing," by Mr. S. C. Downes. 7.30 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, London, S.W. 7. Papers, "Further Remarks on the Meteorological Conditions of the Pleistocene Epoch," by the late Mr. F. W. Harmer and Mr. C. E. P. Brooks, M.A.; "On Periodicity," by Sir Gilbert T. Walker; "On Fluid Motions Produced by Differences of Temperature and Humidity," by Dr. Harold Jeffreys; "Gustiness of Wind in Particular Cases," by Mr. A. H. R. Goldie. 5 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "William Sturgeon and the Centenary of the Electro-magnet," by Dr. J. A. Fleming. 8 p.m.

THURSDAY, MAY 21ST.

INSTITUTION OF MECHANICAL ENGINEERS: MIDLAND HOUSE.—University Buildings, Edgbaston, Birmingham. Second annual conversazione. 6.45 p.m.

FRIDAY, MAY 22ND.

DIESEL ENGINE USERS' ASSOCIATION.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Pyrometry of Exhaust Temperatures of Internal Combustion Engines," by Mr. Charles E. Foster. 3.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Extra general meeting. "Some Tests on a Two-stroke Cycle Oil Engine," by Professor E. A. Allcut. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Connaught Rooms, Great Queen-street, London, W.C. 1. Metropolitan District meeting. 4 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Metabolism of Man and Animals," by Dr. T. M. Carpenter. 9 p.m.

SATURDAY, MAY 23RD.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Shire Hall, Nottingham. East Midland District meeting. 3 p.m.

MONDAY, MAY 25TH.

SOCIETY OF GLASS TECHNOLOGY.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Symposium of papers on "The Constitution of Glass." 7.30 p.m.

TUESDAY, MAY 26TH.

SOCIETY OF GLASS TECHNOLOGY.—Chemistry Lecture Theatre, University College, Gower-street, London, W.C. 1. Continuation of symposium on "The Constitution of Glass." 2.30 p.m. Annual Dinner at the Hotel Cecil, Strand, London, W.C. 2. 7.15 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

FERRANTI, Ltd., asks us to announce that it has to-day moved its London office from 180, Fleet-street, E.C. 4, to Bush House, Aldwych, W.C. 2.

NALDER BROTHERS AND THOMPSON, Ltd., inform us that they have found it necessary to add a new bay to their instrument shop at their Lane Works, 97A, Dalston-lane, London, E. 8.

MR. W. M. SELVEY asks us to announce that he has moved his London office from 66, Victoria-street, to 64, Victoria-street, Westminster, S.W. 1, and that his new telephone number is Victoria 2797.

KASENIT LTD. asks us to announce that it has changed its address from 8 and 9, Ludgate-square, E.C. 4, to Henry-street, Bermondsey-street, London, S.E. 1, to which it requests that all communications should now be addressed. Telephone No., City 3911; telegraphic address, "Monoxide, Boroh, London."

MESSRS. J. F. CROWLEY AND PARTNERS inform us that they have transferred their offices from 16, Victoria-street, Westminster, London, S.W. 1, to No. 11, Queen Anne's-gate, Westminster, S.W. 1, where, in addition to the usual office accommodation, they are providing chemical and physical laboratories for research purposes. Their telephone numbers will remain as before, but the new telegraphic address will be "Cusec, Parl, London."

CONTRACTS.

IN connection with its £14,000,000 renewals scheme, the London, Midland and Scottish Railway has placed an order with the Midland Railway Carriage and Wagon Company, Limited, Birmingham, for a number of 40-ton well trollies. These trollies have a well of 25ft.

VICKERS LTD., of Broadway House, Westminster, S.W. 1, have secured an order for one hundred of their single-battery electrically regulated train lighting equipments for the new passenger carriages which are being built for the London, Midland and Scottish Railway.

HOWDEN-LJUNGSTROM PREHEATERS (LAND), Ltd., has received an order to supply one preheater to the Cauldon Potteries, Ltd., Cauldon-place, Stoke-on-Trent. The total heating surface of the preheater is to be 6220 square feet; air will be supplied to the furnace at about 580 deg. Fah.

STOTHERT AND PITT, Ltd., of Bath, have received an order from the Jersey Piers and Harbour Committee for the complete electrification of St. Helier's Harbour, Jersey. The plant will consist of a number of electric dockside cranes, electric motors for the various workshops and refrigerating plant, the power and lighting cables and the necessary standards and fittings for lighting the jetties and buildings in the harbour.

THE EAST FERRY ROAD ENGINEERING WORKS COMPANY, Ltd., of Millwall, London, E. 14, has received the order from the Great Western Railway for the installation at the Queen Alexandra Docks, Cardiff, of four coaling hoists capable of dealing with 30 tons gross load, each complete with an electrically operated traverser. It has also secured the contract from the same railway company for the installation at Port Talbot Docks of a set of horizontal compound tandem surface condensing hydraulic pressure pumping engines of a capacity of 900 gallons per minute at a working pressure of 750 lb. per square inch. For the Wellington Harbour Board, New Zealand, the company has in hand an order for ten double power (25 cwt. and 55 cwt.) hydraulic semi-portal luffing cranes.